NAVY
PROPOSAL SUBMISSION
INTRODUCTION

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper ((703) 696-8528). The Deputy SBIR Program Manager is Mr. John Williams ((703) 696-0342**).** If you have any questions, problems following the submission directions, or inquiries of a general nature, contact one of the above persons. For technical questions about the topic contact the Topic Authors listed on the website before 1 December 1999. Mail one original and four copies of your Phase I proposal to the address below. Proposals must be received by **12 January 2000**.

Office of Naval Research
ONR 364 SBIR
800 North Quincy Street, RM 633
Arlington, VA 22217-5660

The Navy's SBIR program is a mission-oriented program, which integrates the needs and requirements of the Navy through R&D topics, which have dual-use potential. All Navy SBIR topics fall within the DOD Science and Technology areas and the Navy Science areas, listed in Table 1. Navy topics will be funded from these areas according to a priority it has established to meet its mission goals and responsibilities. Information on the Navy SBIR Program can be found at (**http://www.onr.navy.mil/sbir**). Additional information pertaining to the Department of Navy mission can be obtained by viewing various Navy World Wide Web sites at http://www.navy.mil

UNIQUE NAVY REQUIREMENTS:

1. Navy requires a " DOD Proposal Cover Sheet" (formerly Appendix A & B) to be submitted electronically through the Navy SBIR Website or DOD SBIR Submission Web Site at http://www.dodsbir.net/submission. The company must print out the forms directly from the Website, sign the forms and submit them with their proposal.
2. All Phase I award winners must electronically submit Phase I summary report through the Navy SBIR Website at the end of their Phase I.
3. Phase II award winners must also submit Phase II Summary reports through the Navy SBIR Website.
4. The Navy requires that all Phase II proposers submit a Proposal Cover Sheet & Commercialization Report through the DoD SBIR Submission Web Site. Mail a printed and signed copy of the Proposal Cover Sheet and Commercialization Report only to the Navy SBIR Program Office listed above. Mail the full Phase II proposal with Proposal Cover Sheet and Commercialization Report to the sponsoring Navy activity and technical point of contact.
5. The requirements and time frames for Navy Fast Track submission have been modified and are described below.
6. The Navy only accepts proposals with a base effort less than $70,000 with an option less than $30,000.

NEW IN FY 2000:

1. The Small Business Administration (SBA) has made a determination that will permit the Naval Academy, the Navy Post Graduate School and the other military academies to participate as subcontractors in the SBIR/STTR program, since they are institutions of higher learning.

2. The Navy will allow firms to include with their proposals, success stories that have been submitted through the Navy SBIR Website at (**http://www.onr.navy.mil/sbir**). A Navy Success Story is any follow-on funds that the firm has received from a past Phase II Navy SBIR or STTR awards. To qualify the firm must submit these success stories no later than **13 December 1999,** through the Navy SBIR Website. The success story should then be printed and included as appendices to the proposal. These pages will not be counted towards the 25-page limit. The success story information will be used as part of the evaluation of the third criteria, Commercial Potential (listed in Section 4.2 of this solicitation) which includes the Companies Commercialization Report (formerly Appendix E) and the strategy described to commercialize the technology discussed in the proposal. Commercialization is viewed as any follow-on funds, from the DOD, DOD contractors or the private sector, used to further develop the technology or from sales of a product. The Navy is very interested in companies that transition SBIR efforts directly into Navy and DOD programs and/or

weapon systems. If a firm has never received any Navy SBIR Phase II it will not count against them, and they will be evaluated on the other evaluation criteria listed in Section 4.2 Phase I Evaluation Criteria.

3. Effective with the fiscal year (FY) 2000, no Navy activity will issue a Navy SBIR Phase II award to a company where the elapsed time between the completion of the Phase I award and the actual Phase II award date is eight (8) months or greater; unless the process and the award has been formally reviewed and approved by the Navy SBIR Program Office. Also, any SBIR Phase I contract that has been extended by 'no cost extensions' beyond one (1) year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

4. The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy will provide a 1 to 4 match of Phase II to Phase III funds that a company obtains from an acquisition program up to $250,000 in additional SBIR funds.

5. If you did not submit under 99.2, be aware that there is a new DOD report required to be filed pertaining to commercialization of prior SBIR awards. You can access the required DOD report information through the Navy SBIR electronic submission site.

PROPOSAL SUBMISSION CHECKLIST:

All of the following criteria must be met or your proposal will be REJECTED.

1. The Navy will not accept any proposals from companies that have not submitted the DOD Proposal Cover Sheet (formerly Appendix A & B) and the DOD Commercialization Report (formerly Appendix E) electronically over the Internet. These forms must be printed out directly from this site and be included with the entire proposal that is mailed to the Navy and received by 12 January 2000.

2. Your Phase I proposed cost for the base effort can not exceed $70,000. Your Phase I Option proposed cost can not exceed $30,000. The costs for the base and option should be clearly separate, and identified on the Proposal Cover Sheet, in the cost proposal, and in the work plan section of the proposal.

4. Your proposal must be received on or before the deadline date. The Navy will not accept late proposals, or incomplete proposals. If you have any questions or problems with submission of your proposal allow yourself time to contact the Navy and get an answer to your question. Submit electronic Internet forms early, as computer traffic increases, computer speed slows down. <u>Do not wait until the last minute.</u>

ELECTRONIC SUBMISSION OF PROPOSAL COVER SHEET AND COMMERCIALIZATION REPORT:

Submit your DOD Proposal Cover Sheet (formerly Appendix A & B) and the DOD Commercialization Report (formerly Appendix E) to the Navy using the DOD online submission at http://www.dodsbir.net/submission and as discussed in Section 3.4b and 3.4n of this solicitation. This site allows your company to come in any time (prior to the closing of the solicitation) to edit or print out your appendices. **The Navy <u>WILL NOT</u> accept any forms from past solicitation books or any electronic download version except those from the DOD SBIR Website as valid proposal submission forms.** Detailed instructions can be found by selecting the Help button on this site once you have registered. If you have any questions or problems with the electronic submission contact the DOD SBIR Helpdesk at 1-800-382-4634.

ELECTRONIC SUBMISSION OF PROJECT REPORTS:

The submission of an electronic Phase I Summary Report will now be required at the end of Phase I. The Phase I Summary Report is a non-proprietary summary of Phase I results and should include potential applications and benefits and not exceed 750 words. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR/STTR Website at: http://www.onr.navy.mil/sbir, click on "Submission", then click on "Submit a Phase I or II Summary Report".

NAVY FAST TRACK DATES AND REQUIREMENTS:

All Fast Track Applications and required information must be sent to the Navy SBIR Program Manager at the address listed above and to the designated Contracting Officers Technical Monitor (the Technical Point of Contact (TPOC)) for the contract and the appropriate Administrative Point of Contact listed at the end of this Introduction. A copy of the Fast Track application cover sheet (Reference B) must also be send to the DoD SBIR Program Manager, at the address listed on the back of the sheet. The dates and information required by the Navy are the same as the dates and information required under the DOD Fast Track described in the front part of this solicitation.

ARE YOU A SUPPORT CONTRACTOR FOR A NAVY ACTIVITY ?

Do you have employees occupying space in a Navy activity? Or do you have a support contract to provide services outside of an SBIR Phase I, II or III contract award? Then you must indicate so on the Proposal Cover Sheet form. The Navy is concerned with potential conflict of interest and if you reply yes to either of the above you may be precluded from participation in the Navy's SBIR Program.

YOUR SUBMISSION TO THE NAVY SBIR PROGRAM:

This solicitation contains a mix of topics. When preparing your proposal keep in mind that Phase I should address the feasibility of the solution to the topic. Be sure that you clearly identify the topic your proposal is addressing. The Phase I option should address the transition into the Phase II effort. The Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been invited to submit a Phase II proposal by the Navy technical point of contact (TPOC) during or at the end of a successful Phase I effort will be eligible to participate for a Phase II award (with the exception of Fast Track Phase II proposals). If you have been invited to submit a Phase II proposal to the Navy by the TPOC, obtain a copy of the Phase II instructions from the Navy SBIR Webpage or request the instructions from the Navy Administrative POC listed at the end of this introduction. Phase III efforts should also be reported to the SBIR program office noted above.

The Navy will provide potential awardees the opportunity to reduce the gap between Phases I and Phase II if they provide a $70,000 maximum feasibility Phase I proposal and a fully costed, well defined ($30,000 maximum) Phase I Option to the Phase I. **The Navy will not accept Phase I proposals in excess of $70,000 (exclusive of the Phase I option).** The technical period of performance for the Phase I should be 6 months and for the Phase I option should be 3 months. The Phase I Option should be the initiation of the next phase of the SBIR project (i.e. initial part of Phase II). The Navy will also offer a "fast track" into Phase II to those companies that successfully obtain third party cash partnership funds ("fast track" is described in Section 4.5 of this solicitation). When you submit a Phase II proposal it should consist of three elements: 1) a $600,000 maximum base effort, which is the demonstration phase of the SBIR project; 2) a transition or marketing plan (formerly called a "commercialization plan") describing how, to whom and what stage you will market your technology to the government and private sector; 3) a Phase II Option ($150,000 maximum) which would be a fully costed and well defined section describing a test and evaluation plan or further R&D if the transition plan is evaluated as being successful. Phase II efforts are for two (2) years no more, no less, Phase II options are for an additional six (6) months, any variation requires a waiver from the NAVY SBIR Program Office. You must also submit your Phase II Proposal Cover Sheet and Commercialization Report electronically to the Navy SBIR Program Office at the address above through the Navy SBIR Website. While Phase I proposals with the option will adhere to the 25 page limit (section 3.3), Phase II proposals together with the Phase II Option will be limited to 40 pages (unless otherwise directed by the TPOC or contract). The transition plan should be in a separate document.

The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

TABLE 1. NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY AREAS

TECHNOLOGY AREAS	SCIENCE AREAS
Aerospace Propulsion and Power	Atmospheric and Space
Aerospace Vehicles	Biology and Medicine
Battlespace Environment	Chemistry
Chemical and Biological Defense	Cognitive and Neural
Clothing, Textiles and Food	Computer Sciences
Command, Control and Communications	Electronics
Computers, Software	Environmental Science
Conventional Weapons	Manufacturing Science
Electron Devices	Materials
Electronic Warfare	Mathematics
Environmental Quality and Civil Engineering	Mechanics
Human-System Interfaces	Ocean Science
Manpower, Personnel and Training Systems	Physics
Manufacturing Technology	Terrestrial Sciences
Materials, Processes and Structures	
Medical	
Sensors	
Surface/Undersurface Vehicles/Ground Vehicles	
Modeling and Simulation	

NAVY SBIR PROGRAM MANAGERS OR ADMINISTRATIVE POINTS OF CONTACT FOR TOPICS

Topic Numbers	Point of Contact	Phone
N00-001 to N00-020	Ms. Carol Van Wyk	301-342-0215
N00-021 to N00-026	Mr. Rod Manzano	703-784-4587
N00-027 to N00-034	Ms. Linda Whittington	619-537-0146
N00-035 to N00-037	Mr. Charles Marino	202-764-1553
N00-038 to N00-072	Mr. Bill Degentesh	703-602-3005
N00-073 to N00-095	Mr. Douglas Harry	703-696-4286

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Naval Air Systems Command

N00-001 Advanced Failure Modes and Effect Criticality Analysis (FMECA) Models that Accurately and Quickly Identify Optimum Levels of Diagnostic and Prognostic Requirements

N00-002 Compressor Impeller Erosion Resistant Surface Treatment

N00-003 Auto-correlation of Elevation Data from Digital Stereo Imagery

N00-004 Signal and Cable Integrity Monitoring and Diagnostics

N00-005 Reverse Rotation Capable Brush Seal Design

N00-006 Protective Materials for Aircraft Transparencies

N00-007 Intelligent Tutoring System for Tactical Aircraft Training (ITS-AIR)

N00-008 Environmentally Insensitive Active Decluttering

N00-009 Multistatic Operation

N00-010 Tracking Multisensor Data

N00-011 Military Utility of Automatic Dependent Surveillance - Broadcast (ADS-B)

N00-012 Low-Cost Precision Missile Trackers for Directional Infrared Countermeasures (DIRCM)

N00-013 Middle Game Localization Utilizing Air Deployable Active Receiver (ADAR)

N00-014 Joint Optical Air Data System

N00-015 Development of a Novel Infrared Detector Based on Quantum Well Optical Parametric Amplification (OPA) for Light Detection And Ranging (LIDAR) Receiver Applications

N00-016 Multibeam Sonobuoy Operator Displays

N00-017 Wavelet Compressions to Increase Desktop Personal Computer (PC) Real-Time Texture and Terrain Paging

N00-018 Compact Infrared Countermeasure (IRCM) Jam Head

N00-019 Solid-State Imaging Array for Laser Radar Applications

N00-020 Obsolete Electronic Parts Automated Functional Replacement System

Marine Corps Systems Command

N00-021 Nitrogen Charging System for the Advanced Amphibious Assault Vehicle (AAAV)

N00-022 Small, portable, lightweight, multi-fuel powered electric generators

N00-023 Personnel and Material Tagging

N00-024 Position Location Tracking from Inside Building to Outside Building in an Instrumented Military Operations On Urbanized Terrain (MOUT) Environment

N00-025 Wearable Operator Control Unit

N00-026 Precision Sea-Based Logistics

Space and Naval Warfare Systems Command

N00-027 Link-16 Enhanced Positional Accuracy for Precision Guidance

N00-028 High Frequency Transmit Mast Clamp Current Probe

N00-029 Jammer Placement Artificial Intelligence Tool

N00-030 Wireless Line-of-Sight Networks for IntraBattlegroup Communications

N00-031 Sensor Tasking Segment (STS)

N00-032 Automated Network Anomaly Detection and Fault Tolerance Toolkit

N00-033 Trusted Workstation Using a Plug-in Encryption Module

N00-034 Wideband Radio Frequency (RF) Distribution System

Strategic Systems Program

N00-035 High Precision Depolarized Fiber Optic Gyro (DFOG)

N00-036 MicroElectroMechanical Systems (MEMS) for Ordnance Monitoring

N00-037 Global Positioning Satellite (GPS) Receiver Test Bed

Naval Sea Systems Command

N00-038 Robotic Manipulator for Cargo/Weapons Handling

N00-039 Advanced Fuel Filtration

N00-040 Fire Resistant, Labor Saving, Reduced Weight, Pipe Coupling (Flange)

N00-041 Remotely/Externally Adjustable Valve Actuators

N00-042 Cabling Jackets with Zero Halogen to Meet UL910 Flame Test

N00-043 Enhanced Resistance to Mine Detonation

N00-044 A Dynamic Configurable MCM Assessment Tool for Amphibious Assault Operations

N00-045 Laser Radar (Lidar) Remote Wind Sensor for LCAC

N00-046 Non-Contact Measurement of Ocean Currents

N00-047 LASER Vibration Monitoring of Unmanned Machinery

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N00-049 Innovative Signal Processing Concepts for Active Emissions

N00-050 Smart Tools to Support Shipboard Network Administrators

N00-051 Development a Nondestructive Evaluation (NDE) Technology for Inspecting Structural Welds under Coatings

N00-052 Application of Virtual Large Display Video Goggles to Submarine Imaging Systems

N00-053 Highly Directional Compact UHF Antenna

N00-054 Non-Metallic Bearings

N00-055 Digital Radar Receiver on a Chip

N00-056 Low-Cost Net-Form Fabrication of Hot Gas Valve Components

N00-057 Propulsion Improvement for Long Range Guns

N00-058 Direct Digital Signal Synthesizers

N00-059 Advanced Reactive Materials As Propellants

N00-060 Aerodynamic range extension of guided projectiles

N00-061 Effect of Ocean Waves on Tracking Low-E Objects in Multipath

N00-062 Force Level Automated Certification of Downward Compatible Baseline Software

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N00-066 Operator Assistant for Artillery-Launched Observation Round

N00-067 Upward Compatible Baseline Support Framework For Effective Force Level System Regression Testing and Certification

N00-068 Flexible Sound Source

N00-069 Multi-Static Active Sonar Processing with Unknown Transmission Type and/or Unknown Source Location

N00-070 Innovative Broadband Signal Processing Algorithms

N00-071 Advanced Automated Sonar Operator Machine Interface

N00-072 Multistatic Acoustic Source for Unmanned Underwater Vehicles (UUV)

Office of Naval Research

N00-073 Advanced Compression for Digital Terrain Elevation Data

N00-074 Modeling and Simulation of Decision-making Under Uncertainty

N00-075 Low-Distortion Microwave Active Filters

N00-076 Wide Bandgap AlGaN Based Solar Blind Ultraviolet Photodetectors

N00-077 Four dimensional (4-D) Atmospheric and Oceanographic Instrumentation

N00-078 Heavy Power Transmission for Positioning and Actuation

N00-079 Conjugated Polymers for Corrosion Inhibition

N00-080 Low Thermal Conductance Torque Tube

N00-081 Quiet Turning and/or Nonrotating Devices for Marine Propulsion

N00-082 SiC Bipolar Junction Transistor (BJT) High Power Switch for the Advanced Quite Electric Drive Motor

N00-083 Development of a Finite Element Analysis for Failure Prediction of Large Composite Structures Under Dynamic Loads

N00-084 Composite Gun Barrel

N00-085 Development of a LonTalk Drive Chip (LDC) for High Performance Custom LonTalk Nodes

N00-086 Metrics for Evaluation of Cognitive Architecture-Based Collaboration Tools

N00-087 Real-Time Operator State Assessment Technologies

N00-088 Optimum Organization of Maintenance Aiding Information

N00-089 Compact, Light Weight Color Night Vision Goggles

N00-090 Innovative Air and Surface Strike Weapons Technology

N00-091 Technology for Shipbuilding Affordability

N00-092 Combat System Automated Testing

N00-093 The Manufacture and Integration of Power Building Blocks and Cells for PEBB

N00-094 Fast-response Sensor for the Measurement of the Optical Properties and Carbon Content of Organic Aerosols

N00-095 Real-time Interactive Analysis and Visualization Interface for Environmental Research Data

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NAVY FY00.1 TOPIC DESCRIPTIONS

N00-001 TITLE: Advanced Failure Modes and Effect Criticality Analysis (FMECA) Models that Accurately and Quickly Identify Optimum Levels of Diagnostic and Prognostic Requirements

TECHNOLOGY AREAS: Materials/Processes, Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO-A, Air, ASW, Assault & Special Mission

OBJECTIVE: Develop and demonstrate an accurate and easy to use advanced FMECA modeling capability that would allow timely analysis of various aircraft subsystems.

DESCRIPTION: There is a need to improve and streamline the diagnostic, prognostic, and health management requirement design definition process. The advanced FMECA model can be used to identify the optimum mixture of diagnostic, prognostic, and health management capabilities. This modeling analysis would be used to aid in making the necessary capability and requirements trade-offs in order to define the optimum final system design.

PHASE I: Define and report on a strategy to develop this advanced FMECA modeling capability. Quantify the benefits and boundaries of applying this capability. Develop and demonstrate a prototype modeling capability.

PHASE II: Develop a final application of this advanced FMECA modeling capability to be applied to a major aircraft subsystem, like propulsion. Apply this model to this subsystem (propulsion) and define the resulting optimized diagnostic, prognostic, and health management system requirements. Demonstrate the necessary trade-off functions and resultant benefit areas (life-cycle costs, functional capabilities, etc.). Demonstrate that this general advanced FMECA modeling capability can also be applied to a second major aircraft subsystem. Deliver a software program for evaluation and demonstration.

PHASE III: Develop and deliver a general "global" advanced FMECA modeling capability program that can be used for a complete aircraft system design requirement including all aircraft subsystems. Apply this program capability to a new aircraft diagnostic, prognostic, and health management design. Market and sell the software program.

COMMERCIAL POTENTIAL: This analytical tool could be used in the design and development of any complex system. In particular, commercial manufacturers of fixed-wing or rotor craft aircraft could utilize the FMECA model in applying diagnostic, prognostic, and health management capabilities in their design.

REFERENCES: "Reliability Tool Kit: Commercial Practice Edition" by Reliability Analysis Center, 201 Mill St., Rome, N.Y. 13440-6916, email: dnicholls@mail.iitri.com, web site: www.reliability analysis center

KEYWORDS: Diagnostics; Prognostics; FMECA; System Design; Health Management; Supportability

N00-002 TITLE: Compressor Impeller Erosion Resistant Surface Treatment

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-275, V-22 Osprey Program

OBJECTIVE: The primary objective of the work is to develop an innovative surface treatment for shaft driven compressor (SDC) impellers used in aircraft applications to prevent erosion of the impeller.

DESCRIPTION: The Armed Services presently use SDC's on certain aircraft to provide, among other things, service to on-board inert/oxygen gas separators (OBIGS/OBOGS) and environmental control systems (ECS). Air intakes for these compressors are equipped with particle separators to prevent abrasive material from contacting the impeller. The impellers can operate from 87,000 to 100,000 rpm's (nominal) and at temperatures from 125_F (degrees F) to 600_F (degrees F). Aircraft, particularly helicopters and other vertical/short take-off and landing (VTOL/STOL) aircraft such as the V-22 Osprey, when operating over sandy or dusty landing zones (LZ's) or during dust/sand storms, have experienced rapid erosion of impellers, especially when the particle separator is overtaxed. This can lead to loss of function of critical components and potentially catastrophic system failure. There is a need to provide a surface treatment for SDC impellers, currently made of titanium 6-4 alloy, which eliminates the erosion phenomena or obviates it to an acceptable level.

PHASE I: Complete a development effort that demonstrates the scientific merit and feasibility of providing an erosion resistant surface treatment for SDC impellers for use on military aircraft. The surface treatment must be compatible with current impeller alloys and not degrade other performance requirements of the compressor.

PHASE II: Develop, test, and field demonstrate the surface treatment developed under the Phase I SBIR effort.

PHASE III: Produce the system demonstrated in the Phase II effort. The treatment will be transitioned to the Fleet through specification modifications and revisions.

COMMERCIAL POTENTIAL: A successful surface treatment can be used for SDC impellers for commercial aircraft as well as DOD aircraft and can transition to any other activity needing improved erosion resistant surfaces.

REFERENCES: Picture reference available, phone 301-342-0215.

KEYWORDS: Erosion; Impeller; Surface Treatment; Titanium; Sand; Shaft Driven Compressor

N00-003 TITLE: Auto-correlation of Elevation Data from Digital Stereo Imagery

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA 281 Cruise Missile Command and Control

OBJECTIVE: Develop a robust technique to automatically collect high-resolution, high-accuracy elevation data from stereo photography with a suitably low amount of manual editing.

DESCRIPTION: Precision terrain aided navigation (PTAN) shows promise as a global positioning system (GPS) independent, high-accuracy en route and terminal navigation technique for a variety of platforms, including precision guided munitions like Tomahawk. For terminal navigation, this concept requires high-accuracy, high-resolution elevation data for use as reference maps. (High-resolution here means at most 3 meter post spacing.) To be operationally flexible, this elevation data must be quickly generated from a variety of sources, i.e., automatically. One such elevation source is stereo photography. Automatic generation of elevation data from stereo photography requires an auto-correlator. Current auto-correlators are not sufficiently robust. Although they execute quickly, there are too many elevations generated that require manual editing to meet accuracy requirements.

PHASE I: Develop auto-correlator requirements including accuracy, resolution, manual collection percentage, timing, image quality, etc. consistent with PTAN requirements.

PHASE II: Prototype auto-correlator algorithm and demonstrate with digital point positioning data base (DPPDB) imagery.

PHASE III: Develop complete software package including user documentation for use of auto-correlator as a stand-alone application or as an embedded application within larger systems.

COMMERCIAL POTENTIAL: This software could be used by state and local agencies as well as the private sector for generation of elevation data for a variety of geo-spatial applications such as surveying and earth-resource management.

REFERENCES: "Three Dimensional Computer Vision - A Geometric Viewpoint", by Olivier Faugeras, The MIT Press, Cambridge, Mass,1996.
http://dgrwww.epfl.ch/PHOT/publicat/wks96/Art_3_5.html
http://dgrwww.epfl.ch/PHOT/publicat/wks96/Art_3_1.html
http://www.ncgia.ucsb.edu/conf/SANTA_FE_CD-ROM/sf_papers/miller2_david/miller_paper2.html

KEYWORDS: Precision Terrain Aided Navigation; Terrain Modeling; Stereo Imagery; Tomahawk; Elevation Data; Auto-Correlation

N00-004 TITLE: Signal and Cable Integrity Monitoring and Diagnostics

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-290, Maritime Patrol Aircraft

OBJECTIVE: Develop technology capable of checking cable integrity in engine control and health management systems. The technology would detect, identify, monitor, and isolate signal problems and causes. This capability would reside as a sub-element of an aircraft/engine health management system, and enhance system safety, reliability, and availability.

DESCRIPTION: The increasing use of electronic control and health management systems on aircraft makes the need for consistent and reliable data imperative. As the systems become more complex, and take on more critical aircraft and engine control functions, and as the volume of data increases, the integrity of the data stream must be verified. Intermittent faults, shorts and grounds can cause uncommanded and/or unsafe control inputs. The signal and cable integrity monitoring and diagnostic system would ensure that the data is uncorrupted and help troubleshoot problems when they arise by providing maintenance actions.

PHASE I: Investigate all technologies and software to determine possible applicability to determine signal and cable integrity of aircraft and engine electronic systems. The system must detect, identify, monitor, and isolate signal faults, in real time on an operational aircraft system.

PHASE II: Develop and demonstrate an integrity monitoring system for use on an operational aircraft/engine system that will detect, identify, monitor, and isolate signal faults, in real time. The system will demonstrate the ability to troubleshoot aircraft system faults.

PHASE III: Transition the signal and cable integrity system into a fleet of aircraft as an enhancement to resident electronic control and health management systems, as a sensor system that is integrated with the engine that can detect and monitor disk cracks in real time. The inspection could be done as a separate maintenance action during ground maintenance, but the goal would be to have constant monitoring.

COMMERCIAL POTENTIAL: Although commercial aircraft could utilize this capability, it could also be used to enhance the overall system safety of any electronic control or health monitoring system.

KEYWORDS: Signal; Cable; Diagnostics; On-Wing; Monitoring; Inspections

N00-005 TITLE: Reverse Rotation Capable Brush Seal Design

TECHNOLOGY AREAS: Air Platform

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-275, V-22 Osprey Program

OBJECTIVE: Develop a brush seal design which is capable of accommodating reverse engine rotation for the V-22 Osprey aircraft. The design must be compatible with the existing engine power turbine brush seal dimensions.

DESCRIPTION: Designs are needed to develop a brush seal capable of accommodating both forward and reverse engine rotation. Significant innovation is required to solve the problem of brush seal reverse rotation operation. The V-22 Osprey requires that the AE1107C (T406) engine rotate in reverse during the blade fold wing stow operation. The brush seal design must allow engine reverse rotation within the torqueing capabilities of the rotor phasing unit (RPU) utilized in the propeller rotor positioning segment of the blade fold wing stow sequence. Leakage rates must be similar to those of current brush seal designs throughout the specified minimum mean time between overhaul period of the engine. Proposed designs must fit into the existing seal locations within the V-22 AE1107C engine power turbine section. Minimum impact to the existing engine design is highly desirable.

PHASE I: Produce prototype brush seal design option(s) that can accommodate both forward and reverse engine rotation application within the V-22 AE1107C power turbine section. Emphasis should be placed on leakage rates, engine operating environment, and compatibility with the existing AE1107C design and ground maintenance equipment. Design trades for minimizing leakage rates should also be performed.

PHASE II: Fabricate prototype seal(s) based on Phase I results analyzing dynamic capability of the seal(s). Test seal(s) in a component rig for leakage and dynamic performance demonstrating both forward and reverse rotation capability. Demonstrate compatibility with existing V-22 AE1107C rotor positioning ground unit. Perform preliminary design trade studies to expand the Phase I design to include other military and commercial applications.

PHASE III: Expand the preliminary design trade studies conducted in Phase II to a finalized design which can be utilized on other military and commercial applications. Transition the reverse rotation brush seal technology to a production capable item.

COMMERCIAL POTENTIAL: Commercial applications include gas turbine, turbopump, and other gas path sealing applications that require both forward and reverse rotation operation.

REFERENCES:
1. Rolls Royce Allison AE1107C drawing no. 23051300
2. Rolls Royce Allison AE1107C drawing no. 23063231

KEYWORDS: Brush Seal; Reverse Rotation; Gas Path Leakage; Gas Turbines; Blade Fold Wing Stow; Test and Evaluation

N00-006 TITLE: Protective Materials for Aircraft Transparencies

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-265, F/A-18 Strike Fighter Program

OBJECTIVE: Develop optically transparent materials that can be applied to aircraft transparencies to increase the resistance to abrasion, scratches and chemical attack.

DESCRIPTION: The program will evaluate materials that can be applied to aircraft transparencies made from acrylic or polycarbonate to improve the resistance to impact damage, scratching and chemical attach. Materials that can be coated on or bonded to the outer surface of the transparency will be evaluated. Laboratory evaluation of test coupons will be used to demonstrate improved performance without degradation to physical, mechanical or optical properties of the base material. Successful candidates will then be scaled up to show compatibility with current manufacturing processes and actual transparency shape, size and curvature. Successful demonstration will be followed by commercialization and evaluation for use in other applications such as commercial aircraft and automotive windows.

PHASE I: Select and evaluate protective materials. Test selected materials using simple flat laminates of acrylic and polycarbonate. Develop processes to apply the material. Material selection should be based on (1) light transmission, (2) haze, (3) abrasion, (4) chemical resistance to operational solvents and wind screen cleaning materials (such as Plexus), and (5) adhesion properties of the materials as applied to acrylic and polycarbonate substrates. Assess properties before and after exposure to accelerated weathering. Acrylic test substrates should follow MIL-PRF-8184F, Types I and II, and MIL-P-25690B Class 2 specifications. Polycarbonate test substrate should follow MIL-C-83310 requirements. Evaluate both protected and unprotected samples to determine specific improvement in abrasion and chemical resistance resulting from protective material application.

PHASE II: Further evaluate the best protective materials from Phase I assessment to determine manufacturing processes and to develop data on actual transparencies and wind screens. Scale up the application/manufacturing processes to meet current requirements for fabrication of aircraft wind screens and canopies. The processes of application of a coating or film should be capable of covering the entire outer surface and be compatible with current manufacturing methods. Perform testing to determine optical, abrasion and chemical resistance of the materials on actual canopies and wind screens using standard test methods. Compare the data to standard canopies and wind screens to determine improvements in performance. Make an assessment of the impact of this protective coating on the overall operation of the transparency system.

PHASE III: Scale up the protective material and application process to meet production requirements for military aircraft transparencies. Investigate and develop secondary applications of the material in protecting windows and transparencies for commercial aircraft, automobiles and other vehicles.

COMMERCIAL POTENTIAL: The development of an optically transparent scratch and chemical resistant protective material that is compatible with acrylic and polycarbonate will have a wide range of applications in commercial products. Protection for automobile, truck, bus and subway windows is a large market. In addition, a protective coating for lights, signs and other equipment that is subject to damage from the environment or vandalism is a potentially significant market for this material.

REFERENCES:

1. MIL-PRF-8184F
2. MIL-P-25690B

KEYWORDS: Aircraft Transparencies; Acrylic; Polycarbonate; Scratch Resistant; Coating; Wind Screen

N00-007 TITLE: Intelligent Tutoring System for Tactical Aircraft Training (ITS-AIR)

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA 205, Aviation Training Systems

OBJECTIVE: Develop an instructorless and intelligent tutoring system for deployable tactical aircraft training systems. ITS-AIR is expected to be based upon human-centric design principles, usability analysis, intelligent agent technology, and advanced cognitive modeling.

DESCRIPTION: The Navy is investing in commercial off-the-shelf (COTS) aircraft simulation technology that can be deployed at sea. Simulation systems have been very expensive to develop due to the cost of hardware and software. The requirement for instructors, operators, and maintenance personnel also makes them expensive to operate in the field. New developments in COTS computer technology, self-diagnostic maintenance, on-line technical support, and on-site service contracts will dramatically reduce simulator costs in future years. Simulator instructional systems are handmade for each simulator and require an instructor to operate the system and provide performance feedback to the trainee. The absence of a COTS ITS product for flight simulators increases system development and operational costs and reduces the capability to deploy the system. A generic, intelligent, and instructorless capability may improve usability, reduce costs, and improve the training effectiveness of new simulators. Generic features will allow ITS-AIR to be easily adapted for new tactical aircraft training simulations. The use of intelligent agent technology will optimize human learning and consequently reduce the time to learn. Instructorless operation will increase field use by students and reduce personnel costs by eliminating the need for an instructor/operator.

The context of ITS-AIR will be a reconfigurable aircraft mission rehearsal simulator. While ITS-AIR will initially be applied to a single aircraft type and a restricted set of mission tasks, it must have the capability to be extended to other aircraft types and a full range of missions without major software modification. Desired ITS-AIR capabilities include student control of the training simulation, windowed user interfaces, intelligent mentoring, performance monitoring and diagnosis, adaptive training, flexible cognitive models, rapid reconfiguration for new simulations, and scalability for team/crew training.

PHASE I: Explore alternative feasibility concepts and design a prototype ITS-AIR. The design may consider tradeoffs in the desired capabilities specified in the objective to meet performance and cost objectives. The context of the tutor design will be a Navy tactical aircraft simulation, supported by a cognitive task analysis for the missions to be trained. The design should consider implementation issues on both SGI IRIX and Windows NT operating systems in an object-oriented environment. It should include a detailed description of each ITS-AIR module and user interface, and include discussion of the software interface to facilitate extension of ITS-AIR to other aircraft types and missions. The design should also include plans to incorporate cognitive models and intelligent agents.

PHASE II: Develop, test, and operationally demonstrate a prototype ITS-AIR as formulated under the Phase I effort. The contractor will interface the ITS-AIR to a deployable tactical aircraft-training simulator. The initial set of aircraft and missions to be included in the prototype will be determined at this time. The contractor will determine the value of ITS-AIR by comparing student learning in the ITS-AIR controlled simulator with the same simulator controlled by an instructor.

PHASE III: Once the prototype ITS-AIR has been designed and demonstrated, and its effectiveness has been determined, produce a technology demonstration based on the prototype system developed in Phase II. During this phase, ITS-AIR will be extended to all of the aircraft and missions envisioned for the deployable simulator.

COMMERCIAL POTENTIAL: There are many potential applications for this ITS-AIR. They include other DOD departments and aircraft companies that are developing aircraft mission simulators for training in the U.S. and overseas.

REFERENCES:

1. Anderson, J.R., Boyle, C.F., Corbett, A.T., and Lewis, M.W. (1990). Cognitive modeling and intelligent tutoring. Artificial Intelligence, 42, 7-49.
2. Tambe, M., Johnson, W. L., Jones, R.M., Koss, F., Laird, J.E., Rosenbloom, P.S., Schwamb, K. (1995). Intelligent agents for interactive simulation environments. AI Magazine 16(1).
3. Towne, D.M. (1998). Development of Scenario Tutors in a Generalized Authoring Environment: Feasibility Study. (Office of Naval Research (ONR) Final Report No. 119) Los Angeles: Behavioral Technology Laboratories, University of Southern California.
4. Towne, D.M. (1999, in press) Automated Production of Instructionally Appropriate Scenarios, Proceedings, 8th Computer Generated Forces Conference.
5. Towne, D.M. (1997). Intelligent diagnostic tutoring using qualitative symptom information. Proceedings, American Institute of Artificial Intelligence, Intelligent Tutoring Systems Authoring Tools.

KEYWORDS: Flight Simulation; Training; Intelligent Tutoring; Intelligent Agent; Adaptive Instruction; Aircraft Training

N00-008 TITLE: Environmentally Insensitive Active Decluttering

TECHNOLOGY AREAS: Information Systems, Sensors/Electronics/Battlespace, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-264, Air ASW Systems

OBJECTIVE: Develop or identify signal processing concepts that decrease the sensitivity of active decluttering algorithms to environmental conditions.

DESCRIPTION: Active sonar systems face a significant decluttering problem especially when operating in shallow water. Tactical scenarios present a further complication because response time is critical and, as a result, classification in the fewest number of pings is crucially important. Historically, the decluttering problem has often been addressed by estimating parameters (or clues) of active acoustic returns and classifying the returns based on comparison of these clues against thresholds. There are various approaches to implementing this concept using a sequence of hard decisions or a sequence of soft (i.e., reversible) decisions. Since all of these approaches suffer from the fact that the values of the clues are highly sensitive to the environment, definition of a single set of thresholds is inadequate. One response to this problem, recommended especially in developments targeting tactical applications, has been to de-emphasize the use of environmentally sensitive clues and rely more heavily on kinematic information derived from tracking the acoustic returns over multiple pings. Though this can reduce the performance sensitivity to the environment, the disadvantages are that it requires some minimal target motion and requires some minimum number of pings to build a track. Other concepts to reduce environmental sensitivity have typically attempted to adapt to the environment by adjusting the clue thresholds or the actual choice of which clues to use. These concepts primarily consider modifications to the information processing algorithms (i.e., the processing done on the data after it has been filtered, beamformed, normalized and detected).

The emphasis of this study would be to develop a unique approach to reducing the environmental sensitivity of active decluttering algorithms. The goal is to explore signal-processing techniques that reduce the variability of the processed acoustic returns presented to the information processing algorithms. More specifically, the goal is to develop signal-processing techniques that yield consistent results across all environments so that a single set of clues and thresholds can be defined to distinguish targets from clutter. The signal processing approach developed here should focus on features which are independent of target motion relative to the sensor or effects of the environment.

PHASE I: Define the signal processing to be used. Define measures of effectiveness (MOEs) and estimate the potential of the proposed processing to achieve environmental independence. Estimate potential classification performance improvement in terms of lack of sensitivity to the environment. For the purpose of this initial evaluation, reasonable assumptions about the effectiveness of the signal processing concepts can be made without extensive validation.

PHASE II: Implement the signal processing concept selected in Phase I and perform an extensive evaluation, against actual at-sea data from at least two Navy sonar systems, of the effectiveness and the impact on decluttering performance. Based on the evaluation, modify (if necessary) the signal processing concept, select a single set of clues and a single set of thresholds, and use these to measure actual classification effectiveness across a large number of diverse environments.

PHASE III: Implement the concept defined in Phase II for use with a selected Navy sonar system during at-sea testing. Design a series of at-sea tests to evaluate how robust the decluttering and classification performance of the system is across a number of diverse environments.

COMMERCIAL POTENTIAL: Methods developed in this SBIR could be used for commercial applications that utilize active probe signals and must discriminate against high levels of clutter such as seismic exploration/profiling, weather radars, and commercial search radars.

KEYWORDS: Decluttering; Classification; Sonar; Active Signal Processing; Environmental Adaptation; Shallow Water

N00-009 TITLE: Multistatic Operation

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-264, Air ASW Systems

OBJECTIVE: Develop effective bistatic/multistatic capabilities for two specific combinations of Navy sonar systems, which impact air antisubmarine warfare (ASW) operations.

DESCRIPTION: Multistatic operation of Navy sonar systems can potentially improve overall ASW effectiveness despite significant improvements in the capabilities of potential submarine adversaries. As enemy submarines become quieter and more capable, utilization of active sonar techniques becomes necessary to maintain tactically effective ASW ranges for detection, classification, and localization. Active sonar operation in shallow water environments is in turn complicated by the severe clutter that is encountered. Multistatic operation enables Navy forces to take full advantage of active sonar capabilities and to improve decluttering performance while allowing critical assets to remain acoustically covert. Multistatic capabilities for all viable combinations of U.S. Navy sonar systems eventually need to be developed. However, two specific multistatic scenarios are of particular near-term interest to the Navy. Consideration of these particular scenarios will provide general insight into multistatic operation that will apply to other sonar systems.

The first such scenario consists of multistatic operation of one or more SH-60R platforms, utilizing the AQS-22 airborne low frequency sonar (ALFS) dipping sonar, along with one or more surface ships utilizing the present SQS-53C system and (in the future) the multi-frequency towed array (MFTA) system. The only step to date that has been taken to allow these systems to operate multistatically is that their operational frequency bands overlap.

Innovative modifications to waveforms, signal processing, information processing, and display processing will need to be made. The second scenario of near-term interest to the Navy is multistatic processing of sonobuoys utilizing advanced sources like improved extended echo ranging (IEER) or low- frequency active (LFA). There are numerous ongoing efforts evaluating the effectiveness of using air deployable active receiver (ADAR) sonobuoys as the receive sensor in this scenario. However, the Navy already has a tremendous inventory of directional frequency analysis and recording (DIFAR) sonobuoys available to it. Understanding the innovative processing options using a mixture of the existing DIFAR sonobuoys along with ADAR sonobuoys will allow the Navy to make informed decisions about the most cost-effective use of its sonobuoy assets. Innovative modifications to signal processing, information processing, and display processing are sought.

PHASE I: Identify and address both scenarios to a level of detail that allows a preliminary estimate of potential improvement in ASW effectiveness. Develop candidate approaches for deployment strategies based on the environmental conditions. Identify potential modifications to signal processing, information processing, and display processing. Identify required sea-test data to support a laboratory evaluation of these concepts.

PHASE II: Implement concepts developed in Phase I and evaluate effectiveness against simulated data and sea-test data. Implementation and comparison of multiple concepts will be done wherever warranted. Identify portions of implementation that are especially sensitive to "real-world" effects and design an at-sea test plan to evaluate performance. All software should be developed in a manner that simplifies potential future integration into existing Navy systems.

PHASE III: Develop and integrate real-time implementation of processing changes into Navy-selected platforms for the purpose of supporting extensive at-sea testing. The software product should be flexible enough to support testing but robust enough to simplify conversion to "fielded" software if test results support such an action.

COMMERCIAL POTENTIAL: Methods developed in this SBIR could be used for commercial multisensor applications like seismic exploration/profiling or monitoring of off-coast drug trafficking where coordination of multiple sensors is necessary and (in the drug trafficking application) where covertness of certain platforms is highly desirable.

KEYWORDS: Multistatics; Environmental Adaptation; Sonar; Signal Processing; Classification; Decluttering

N00-010 TITLE: Tracking Multisensor Data

TECHNOLOGY AREAS: Information Systems, Sensors/Electronics/Battlespace, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO-A, Air, ASW, Assault & Special Mission

OBJECTIVE: Develop a robust multisensor tracking capability for active and passive sensors for use in scenarios that include sonobuoy fields.

DESCRIPTION: There are many Navy antisubmarine warfare (ASW) scenarios where data from multiple acoustic sensors must be combined to form target tracks. Specifically, existing trackers in the U.S. Navy inventory have difficulty combining data from sonobuoy fields (both active and passive) to effectively track targets. Similarly, existing trackers do not effectively combine sonobuoy data with data from a dipping sonar. Such scenarios pose a number of unique problems. Passive sonobuoys have limited range so the amount of time that a single target is tracked concurrently by multiple sonobuoys is limited. Many passive sonobuoys are limited to providing only bearing information, and the bearing information is typically much coarser than other sonar systems can provide. The very nature of how a helicopter dipping sonar is used means that acoustic dipper data is only available intermittently. Additionally, the existing trackers require an extensive amount of operator interaction to initiate tracks and to correlate tracks from different sensors. Historically, incorporation of the information available from passive and active sonobuoys and from the active dipping sonar has not been done as an integrated, system-level design. The goal of this effort would be to develop a single integrated tracker that combines sonobuoy and dipping sonar acoustic returns to try to maintain uninterrupted tracks with a minimal level of operator interaction. The tracker design must also address multi-static operation with the sonobuoys and dipping sonar acting as the receivers for sources that include directional command activated sonobuoy system (DICASS) sonobuoys, the dipping sonar and improved extended echo ranging (IEER) sonobuoys. Performance of the tracker will be used to evaluate present sensor deployment tactics and identify any desired modifications to those tactics.

PHASE I: Define a tracking algorithm that addresses the specific multisensor, air ASW scenario described above. Derive preliminary estimates of various thresholds and association gates based on evaluation against simulated data. Develop preliminary estimates of the maximum gaps in target track data that can be tolerated. Estimate expected gaps in target track data based on present sensor deployment tactics. Determine whether potential tracker performance and reasonable changes in deployment tactics can support uninterrupted target tracking.

PHASE II: Confirm preliminary findings from Phase I by evaluating tracker performance against actual at-sea recorded data for a large variety of noise background levels, clutter levels and signal-to-noise ratios (SNRs) of the target acoustic signals (both passive and active). If sufficient at-sea data is not available to evaluate tracker performance for multi-static operation, then insertion of artificial target returns into actual recorded background data can be used. Identify whether in situ environmental measurements can be used to improve system robustness by adapting the tracker to the environment.

PHASE III: Implement the tracker from Phase II and perform at-sea testing to validate performance of the tracker under actual operational conditions. Both monostatic and multistatic operations will be tested.

COMMERCIAL POTENTIAL: Methods developed in this SBIR could be used for commercial multisensor tracking or localization applications like seismic exploration/profiling or monitoring of off-coast drug trafficking.

KEYWORDS: Sonar; Signal Processing; Tracking; Multistatics; Dipping Sonar; Sonobuoys

N00-011 TITLE: Military Utility of Automatic Dependent Surveillance - Broadcast (ADS-B)

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-209, Air Combat Electronics

OBJECTIVE: Explore the dual use of rapidly emerging civil ADS-B technology to address military applications such as combat identification, command and control, situational awareness, military air surveillance, and range clearance.

DESCRIPTION: The advancement of ADS-B technology is moving at a rapid pace within civil aviation. During the 1996 Olympics, ADS-B Helicopter Traffic Separation very successfully provided improved situational awareness and enhanced safety. The Cargo Airline Association has already completed demonstrations of this technology and will conduct an operational evaluation of ADS-B systems in the summer of 1999. The ADS-B minimum aviation system performance standards (MASPS) were published as RTCA DO-242 and both the minimum operational performance standards (MOPS) for 1090 MHz ADS-B and cockpit display of traffic information (CDTI) have been drafted and will be published in 1999. The participation of the DoD in the development of ADS-B has been negligible. It is time to explore the promising usefulness of civil ADS-B for military applications.

PHASE I: Study the feasibility of using civil ADS-B technology for military applications. Explore the feasibility of using ADS-B functionality to address primary mission deficiencies in command and control and combat identification while improving situational awareness and safety. Analyze the potential impact of ADS-B on current tactics, techniques, and procedures (TTP).

PHASE II: Develop a development plan, perform prototype development and demonstrate the integration of prototype system into a selected military aircraft. Test and operationally demonstrate both the civil and military ADS-B functionality studied during Phase I.

PHASE III: Transition the ADS-B prototype system into a Naval Aviation program managed by PMA-209 and other applicable programs. Develop a common ADS-B integration approach on other Navy and Marine Corps aircraft.

COMMERCIAL POTENTIAL: ADS-B is based on civil technology. The hardware and software developed and demonstrated during this SBIR effort should have many applications for General and Business aviation. The cargo airlines association CAA is evaluating the potential of ADS-B for traffic awareness and deconfliction. Through 1999 and 2000, considerable work is progressing for ADS-B development. General aviation applications are yet to be determined.

REFERENCES:

10 RTCA DO-242 ADS-B MASPS
20 RTCA DO 181A, ch 1&2, ATCRBS / Mode S MOPS

KEYWORDS: Surveillance; Situational Awareness; Automatic Dependent Surveillance - Broadcast; RTCA; Dual Use; Safety

N00-012 TITLE: Low-Cost Precision Missile Trackers for Directional Infrared Countermeasures (DIRCM)

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-272, ATAPS Tactical Aircraft Electronic Warfare

OBJECTIVE: Utilize uncooled image intensified charge coupled device (I2CCD) arrays for precision missile tracking during the laser infrared (IR) jamming function. I2CCDs would replace expensive, low-reliability, cooled IR focal plane arrays (FPAs) while at the same time improving performance.

DESCRIPTION: There is a need for IRCM system counter threats that are difficult to defeat using conventional IRCM techniques. Because the new generation of threats are more capable, IRCM energy must be directed at the threat missile to obtain sufficient energy on target to cause it to miss the aircraft. In order to attain the energy on target, an IR jammer must be able to track the threat missile with enough accuracy to point a laser at the threat missile. Current IR detectors in tracking sensors are expensive and must be cooled in order to achieve the sensitivity needed to track IR missile threats in all phases of flight. The coolers used with the detectors are least reliable part of the sensor. These coolers cause a reduction in the reliability of the tracking sensor, increase maintenance requirements, and increase the cost of the sensors. developing an uncooled IR detector for the tracking sensor will reduce the design complexity, reduce the production costs and increase the reliability of the tracking sensor.

PHASE I: This phase consists of characterizing the IR radiation characteristics of threat missiles from 0.5 to 1.1 microns during day and night operation for all phases of missile flight. Determine the feasibility of using the uncooled detectors in sensors for tracking threat missiles in all phases of flight. Evaluate expected sensor resolution and estimate the costs to produce the detectors. Prepare performance requirements for the uncooled IR detectors in a tracking sensor. Prepare a report documenting the findings.

PHASE II: Integrate I2CCD prototypes and precision tracking software with existing precision gimbal systems for nondisruptive/cooperative testing on prescheduled DoD missile warning system (MWS)/IRCM/DIRCM live missile firing programs. Demonstrate precision and leading edge missile tracking during both motor burn and post-burnout flight phases. Define I2CCD engineering development model configurations suitable for potential inclusion in the DoD DIRCM, Advanced Threat Infrared Countermeasures (ATIRCM), Tactical Aircraft Directed Infrared Countermeasures (TADIRCM), and Laser IRCM Flyout Experiment (LIFE) programs/hardware. Refine potential engineering, manufacturing, and development (EMD) cost estimates and life-cycle cost savings associated with utilization of I2CCD technologies in lieu of cooled IR FPA precision cameras. Define I2CCD critical item development specifications.

PHASE III: Conduct EMD efforts focused on providing low-cost common module I2CCD precision tracking cameras for all DoD directional IRCM systems.

COMMERCIAL POTENTIAL: The integration of I2CCD cameras with the available precision missile tracking algorithms/software is ideal for affordable commercial surveillance systems such as plant intrusion security, border security/surveillance, bird detection at commercial airports for aircraft safety, helicopter tracking of suspect vehicles during high-speed police pursuits, etc.

KEYWORDS: Directional IRCM; Laser IRCM; Image Intensified Charge Coupled Devices; Uncooled Sensors; Leading Edge Track Algorithms; IR Jamming

N00-013 TITLE: Middle Game Localization Utilizing Air Deployable Active Receiver (ADAR)

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-264, Air ASW Systems, PMA-290, Maritime Patrol Aircraft

OBJECTIVE: A typical air antisubmarine warfare (ASW) mission can be divided into three parts. During the beginning of the mission, utilizing prior knowledge, an ASW aircraft will attempt to greatly reduce the area of uncertainty (AOU) using active assets (which in the future are projected to be improved extended echo ranging (IEER)). Then the aircraft will often transition to a passive attack in the hopes of obtaining a closest point of approach (CPA). Currently, this is accomplished with directional frequency analysis and recording (DIFAR) sonobuoys. The kill is then accomplished with directional command activated sonobuoy system (DICASS) sonobuoys. The ADAR sonobuoy has a passive capability, a capability at this point that is largely untapped. The purpose of this effort is to develop the capabilities of the ADAR sonobuoy for the middle phase.

DESCRIPTION: The ADAR sonobuoy passed OPEVAL (Operational Evaluation - a series of tests designed to see if the system is ready for manufacture) recently and is in production. During this evaluation most of the testing was done on the active capabilities of ADAR. The sonobuoy also has a passive capability, which as mentioned above, could be utilized during the passive phase of a localization procedure. The purpose of this SBIR would be to develop passive processing systems utilizing the ADAR sensor.

PHASE I: Phase I would first involve an evaluation of the passive capabilities of the ADAR sonobuoy. In a proposal addressing this requirement, serious thought should be given to the time constraints involved in this evaluation and to how it might reasonably be obtained. The second part of Phase I would be the area in which there would be significant technical risk: specification of algorithms and systems that could be utilized to process the ADAR sensor received data.

PHASE II: Phase II would be the development of a demo system built to the specifications developed in Phase I. The requirement would be strictly for a demo, i.e., a system to show the feasibility of the passive algorithms and processing systems. No constraints would be placed on the contractor regarding the development of this demo system. Any system giving approximately the same detection performance as a DIFAR-based system would be acceptable.

PHASE III: Develop cooperative arrangement between the SBIR contractor and the prime contractor for ADAR so as to enhance ADAR's passive capabilities. Since currently not much effort has been expended on the passive systems, there would be much potential for improvement of ADAR by a small business contractor.

COMMERCIAL POTENTIAL: Potential commercial uses of the technology developed under this topic would primarily be in two areas: seismic processing and medical monitoring technology. The digital processing improvements that would come out of this topic could greatly improve the passive sensor instrumentation and processing utilized in these two areas.

REFERENCES: 10 ADAR Performance Sonobuoy Specification (PSS) dated 10/9/98

KEYWORDS: Passive; Digital: Array; Beamforming; Detection; Classification

N00-014 TITLE: Joint Optical Air Data System

TECHNOLOGY AREAS: Air Platform, Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-265, F/A-18 Strike Fighter Program and PMA-276, H-1 Program

OBJECTIVE: Design, Develop, Fabricate and Demonstrate Optical Air Data System (OADS) Optimized for a JSF Application

DESCRIPTION: The Naval Air Warfare Center and Air Force Research Laboratory have conducted research to demonstrate the viability of the OADS concept. An OADS emits laser energy into the atmosphere, out of the influence of the aircraft, and detects the return signal from backscattered light. The return light energy is Doppler shifted so that by determining the frequency shift of the return light from the outgoing energy, the line-of-sight velocity can be determined. The backscattered light is compared against the outgoing laser frequency spectrum; temperature can be determined by measuring the increased width due to molecular broadening caused by temperature; and pressure can be derived by measuring the density, which is directly related to intensity magnitude of the backscattered light. With at least three line-of-sight determinations, the aircraft velocity, angle-of-attack and angle-of-sideslip can be determined. The advantages of an OADS approach are lower calibration costs (measurement made in ambient atmosphere, common system across aircraft platforms), higher survivability (no radar cross section (RCS) penalty from forward-looking air data probes), and larger operating envelopes (no inherent speed or angle-of-attack limitations as in pneumatic systems). Significant research and development has been conducted on particle-based backscatter optical systems that rely on backscattered light from aerosols for the signal source. Unfortunately, this approach is susceptible to data dropouts in a “clean” atmosphere and still requires independent measurements of ambient pressure and temperature (which require calibration to reduce platform induced effects on the measurements). The Navy and Air Force have jointly sponsored Optical Air Data research using molecular-based backscatter which eliminates the negative consequences of aerosol based systems. This approach requires a much shorter wavelength (0.266 microns vs. 1 – 10 microns for aerosol systems). Source alternatives include lasers that emit light at this wavelength (not available at the size and power levels needed) or use of optical doublers (very inefficient and not easily integrated into flight environment) to shift IR laser output light to a higher frequency. The current program hopes to achieve a flight demonstration with limited objectives this fall. Available laser power and optical efficiencies will limit velocity update rates to 1 Hz. Temperature and pressure measurements, which can be determined from the shape of the return waveform, will be measured at 0.1 Hz. It is recognized that this program is insufficient to get the technology matured sufficiently for Engineering, Manufacturing and Development. An important aspect of future research is to increase laser power and improve photonic efficiencies at the short wavelengths.

PHASE I: Design a prototype OADS that can operate in the airborne environment within the constraints of a multi-variant JSF aircraft and has maximum flexibility for installation and testing in several classes of air vehicle platforms. Analysis shall identify system level requirements based on JSF air data requirements (velocity at 20 Hz, angle of attack at 40 – 80 Hz, pressure/temperature at 20 Hz with 1% accuracy on velocity/pressure/temperature and 0.5 deg on angle of attack with acceptable weight, volume, and power constraints). Considerable attention shall be given to the optical chain requirements including the laser to identify and execute a technology maturation path that achieves this level of performance with moderate risk. New and innovative means to generate the required laser power at the short wavelengths may be considered within these risk constraints.

PHASE II: Fabricate and test an OADS that is viable for JSF application. Identify any additional engineering/demonstration required to transition to engineering and manufacturing, development (EMD) and coordinate under the auspices of a prime aircraft contractor. The culmination of Phase II will be a flight demonstration. Identify and measure weather and aircraft environmental impacts on system performance during flight. Develop technical risks along with risk mitigation and technology maturation investment roadmaps clearly projecting technology maturation needs and required investment for technology transition to EMD.

PHASE III: Adapt the OADS system to a wind shear and gust alleviation device. Identify requirements for JSF, high-speed civil transport, and commercial airliner applications. Identify critical technology elements and required technology maturation. Develop unique technologies required for adaptation of OADS to wind shear and gust measurements. Atmospheric measurements shall be made at a sufficient distance from the aircraft-about 0.5-1 km for gust response, 5-10 km for wind shear avoidance-so that reasonable warning or inputs to the vehicle control system can be generated. Implications on laser power and optical chain requirements shall be clearly defined. Design, fabricate, test, and validate system performance as an optical air data sensor and wind shear/gust alleviation system. Evaluate performance in a flight environment and assess suitability for multi-aircraft type operation.

COMMERCIAL POTENTIAL: There are two primary advantages of the application of this technology to the commercial sector: multifunction operation and commonality. With additional engineering and development, this technology can be extrapolated to a wind shear detection and gust alleviation system. This application has seen considerable technology investment in recent years due to a rash of aircraft wind shear induced incidents. An optical sensor has a considerable advantage over pneumatic approaches because an optical system can measure considerable distances ahead of the aircraft, where pneumatic air data is limited to making measurements near the aircraft's skin. A wind shear detection and gust alleviation system can significantly impact safety and ride qualities and possibly provide weight savings for new aircraft designs. If the engineering is done for multiple function operation, it should be possible to operate an OADS simultaneously as a wind shear and gust sensor as well as an air data system. In addition, a considerable cost savings can be realized due to the fact that minimal calibration is required. The same system can be installed across aircraft types for equipment and supplier commonality. Modifications can be made to the outer mold line with no impact on air data system performance.

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KEYWORDS: Optical Air Data; Laser Velocimeter; LIDAR; Flight Control; Air Data; Laser

N00-015 TITLE: Development of a Novel Infrared Detector Based on Quantum Well Optical Parametric Amplification (OPA) for Light Detection And Ranging (LIDAR) Receiver Applications

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-201, Conventional Strike Weapons

OBJECTIVE: Develop an infrared detector based on quantum well OPA for use in LIDAR systems.

DESCRIPTION: The Navy is developing a low-cost, compact infrared detector for LIDAR systems based on OPA technology. OPA detectors provide for an optical gain of several thousand with a significantly better signal-to-noise ratio as compared to conventional photo diode detectors with electronic amplification. To obtain low manufacturing cost, compact size, and high performance, it is necessary to develop an improved OPA device that can be integrated with high-performance, high-speed detectors. The newly emerging photonic band gap technologies based on III-V quantum wells provide a unique means for greatly improving the effective nonlinear coupling coefficients needed for a large gain and robust OPA operation. The goal of this topic is to construct a quantum well photonic band gap OPA device.

Quantum Well OPA design studies must include photonic band gap structure; electronic band gap structure; materials composition; electrical and nonlinear optical properties; optical gain; and phase-matching bandwidth for temperature, angle, and frequency. Specific Navy design requirements are:

- Capable of large-scale production
- Low cost
- Allow for variability of pump, signal and idler wavelengths
- Accommodate different types of photo detectors

PHASE I: Develop a photonic band gap OPA device structure concept for detecting infrared light in LIDAR systems. Perform a feasibility study that clearly demonstrates the functionality of the concept. The study must include a thorough analysis of the gain, noise, speed, and conversion efficiency of the proposed detection concept, as well as an experimental demonstration of the essential features of the concept.

PHASE II: The primary goal of Phase II is to demonstrate a working detector which is based on the concept developed during Phase I. The work will include developing the capability to manufacture arrays of such devices for use in LIDAR systems. This phase will also include performance tests of the detectors that demonstrate the overall improvements in signal to noise ratio, speed, gain, and efficiency of the devices.

PHASE III: Integrate the detectors into a working LIDAR system and demonstrate the benefits of the performance enhancements during flight tests.

COMMERCIAL POTENTIAL: The benefits of this research will include the development of high-performance arrays for missile defense, surveillance, and countermeasure sensors for both military and commercial use. This research will also support development of noninvasive medical sensors for use in drug screening, blood testing, and other diagnostics requiring high sensitivity to infrared signals.

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KEYWORDS: Optical Parametric Amplification; Quantum Well Detector; LIDAR; Nonlinear Optics; Photonic Band Gap Structure; Quasi Phase Matching; Infrared; High-Speed Detectors

N00-016 TITLE: Multibeam Sonobuoy Operator Displays

TECHNOLOGY AREAS: Information Systems, Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-264, Air ASW Systems, PMA-290, Maritime Patrol Aircraft

OBJECTIVE: Design efficient/effective methods of providing an undersea warfare (USW) operator of a multistatic active acoustic system with an on screen color display of one or more search and analysis formats that can handle multiple beam (up to 24 per sonobuoy) data from sonobuoys for the detection of underwater targets of interest.

DESCRIPTION: Presenting a vast amount of acoustic data to a USW operator on a single screen effectively so that the operator can quickly review all contacts (passive and active, monostatic and bistatic) and then rapidly review expanded areas of interest (snippets) can present a work overload situation which will eventually reduce an operator's ability to detect a target of interest. With the introduction of color displays to USW suites, color itself will be of great value, but the multibeam data must still be presented to the operator in a manner, that can be related to the search area. With the advent of multibeam sonobuoys such as the air deployable active receiver (ADAR) sonobuoy, new display formats and techniques need to be investigated to provide the most effective operator-machine interface available for data interpretation. An operator must easily and, preferably, simultaneously, view all data from a minimum of four multibeam sonobuoys on a single monitor and have it presented in a fashion that permits quick, detailed analysis of signals of interest. The display formats must handle the minimum number of four sonobuoys' data. Color should be thought of as one of many coding dimensions available for display design. The number and set of colors chosen should allow for increased search rate, signal detection(s), and reduced operator workload while in an operational USW mission environment. Investigations should include, but not be limited to, bearing versus time (BVT) and amplitude scan (A-Scan) formats.

PHASE I: Develop 24-beam display formats to display data from four ADAR sonobuoys. Present the investigated formats to a Naval Air selected group of USW operators and engineers for choice selection.

PHASE II: Design software on a commercial off-the-shelf (COTS) platform to implement the Naval Air selected display format from Phase I incorporating the use of simulated or unclassified real ADAR data.

PHASE III: Integrate the Phase II software into air or sea platforms for Fleet use.

COMMERCIAL POTENTIAL: Future development of radar displays

KEYWORDS: Undersea Warfare; Displays; ADAR; Multistatic; Sonobuoys; Multibeam

N00-017 TITLE: Wavelet Compressions to Increase Desktop Personal Computer (PC) Real-Time Texture and Terrain Paging

TECHNOLOGY AREAS: Information Systems, Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO-T, Tactical Aircraft

OBJECTIVE: There is a need to develop a powerful wavelet compression and paging scheme. The scheme would be linked into current run-time application programming interface (API) simulation applications that allow textures and terrain to be compressed on the disk to save disk size and decompressed on the fly in system memory or texture memory to save memory. This would reduce the input/output (I/O) and memory requirements of the system to support extremely high-resolution terrain and textures for real-time simulation applications on desktop PCs.

DESCRIPTION: The current state of the art in high-performance scene visualization is to use joint photographic expert group (JPEG) or color space compression. This allows current I/O systems to move more megabytes (MB) of information over the same wire/bus. The more information that can be moved, the higher the potential resolution of the textures or the speed the eye-point may move through the environment without anomalies. However, JPEG and color space compression have unacceptable artifacts when used to perform very high compression and require hardware-accelerated cards to limit the impact on the desktop central processing unit (CPU). These two compression methods are also limited to the textures and cannot be applied to the terrain, which is the second largest user of space and bandwidth in high-resolution applications. The intent of this effort is develop a wavelet compression scheme that can be applied to both the textures and the terrain, and is compatible with the large number of commercial-off-the-shelf (COTS) run-time API and desktop PC systems.

This method will save on bandwidth and disk storage through the increased compression. It is also expected that only the highest resolution of the texture maps will have to be saved and that the lower level mip-map textures will be generated on the fly by decompression to the intermediate stages. This should result in a decrease in disk and bandwidth of 33 percent. Application of similar savings in the terrain area is also expected through similar methods. In addition:

_ Application of wavelets on images that are material based at each pixel, versus color based at each pixel, should be considered with the advent of sensor simulation.

_ Application of wavelet storage and decompression of textures in the on-board texture memory of PC video cards to allow for more optimal use of memory should be considered when developing the wavelet and software paging algorithms.

PHASE I: Provide a feasibility study of wavelet compression applicability to texture and terrain for use in real-time simulation applications. The study should include demonstration of the wavelet algorithms in a pager configuration, and the ability to link the pager to a current run-time API or embed it in an open graphics language (OpenGL) application. The report should include a discussion of the impact on positional and context accuracy of the wavelet algorithm on the texture images and terrain.

PHASE II: Develop a wavelet compression/decompression engine that supports off-loading the CPU processing and a peripheral component interconnect (PCI) or equivalent IEEE standard interface format. Develop the tools to automate the development of wavelet compressed disk files for use in simulation. The system should provide the functionality and critical performance aspects of a final system, but the physical package may not be the final form.

PHASE III: Develop a production prototype card and software. Demonstrate the system working in several production real-time API environments and on several PC hardware systems. This unit should be rugged and approach the final production form. It should have full operational performance and serve as a production prototype. Investigate the ability to embed the wavelet engine in several COTS PC video cards to develop a turn-key solution.

COMMERCIAL POTENTIAL: This technology will be useful in geographic information systems (GIS), medical imaging, the computer gaming industry, and other commercial imaging applications, such as increased storage of digital still photographic images.

KEYWORDS: Texture; Terrain; Compression; Wavelet; Mission Planning; Low-Cost PC

N00-018 TITLE: Compact Infrared Countermeasure (IRCM) Jam Head

TECHNOLOGY AREAS: Air Platform, Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO-T, Tactical Aircraft

OBJECTIVE: Develop a compact infrared laser transceiver for use in tactical aircraft for IRCM.

DESCRIPTION: There is a need for the development of a lightweight, compact laser transceiver for use on Navy tactical (TACAIR) aircraft. The transceiver must support the functions of the TACAIR IRCM concept including and acting as a mid-wave infrared receiver/tracker and an open-loop IRCM laser transmitter/beam-director. The Navy is seeking innovative approaches to the design of hardware to perform the tracking and jam functions. Present system uses mirrors and articulated arms redirect the laser beam and IR images in desired directions. These take up a large fraction of the size and weight allocated for the system. The goal of this SBIR topic is to develop an IRCM Jam head concept that is practical and affordable to build. Proposals will be ranked on complexity, cost and practicality. The jam head must be able to transmit and receive mid-wave infrared (MWIR) signals over an angular coverage of at least 90 degrees with a 1 milli-radian degree resolution.

PHASE I: Perform a concept design and feasibility study to address the following areas: a) jam head design and layout; b) receiver/tracker and laser transmitter/beam director performance analysis; and c) jam head size, weight, power, and cost estimate.

PHASE II: Build and demonstrate a prototype IRCM jammer and deliver it to the Naval Air Warfare Center.

PHASE III: Build a production ready model of the jam head for field test and demonstration.

COMMERCIAL POTENTIAL: This technology could be used in a laser based remote sensing applications. For example, pollution monitoring sensors to detect oil pipeline leaks or other applications where there is a need to detect molecules from a distance. This system could also be used for surveillance applications, for example, non-cooperative air or ground identification for both the military and the law enforcement community.

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KEYWORDS: Infrared Countermeasures (IRCM); Midwave Infrared (MWIR); Jam Head; Laser; Receiver/Transmitter; Tracker/Beam Director.

N00-019 TITLE: Solid-State Imaging Array for Laser Radar Applications

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO-T, Tactical Aircraft and PMA-231, E-2/ATDS

OBJECTIVE: Develop a two-dimensional high-speed optical detector array for laser radar imaging operating at the eye-safe optical wavelength of 1.55 microns.

DESCRIPTION: The Navy is currently using solid-state photo diode optical detector systems for optical communications and one-dimensional laser radar systems. Low-level laser radar signal applications require detection systems exhibiting high gain and low noise. Given the ever increasing demand for low-level signal capability over a wider bandwidth, noise levels of present detector systems will impose signal processing limits on future laser radar systems. Future systems will also demand discrimination and resolution capabilities unavailable with single detector systems. The proposed effort will provide a 5 x 5 low-noise optical detector array based on 1.5 GHZ - 2 GHZ pin diode or avalanche photo diode technology with a pixel detector element diameter of 25 microns operating in the eye-safe wavelength region of 1.55 microns. It offers significant improvement of signal to noise and resolution over present systems. This effort will increase the range and overall capability of laser radar systems.

PHASE I: Define a practical and affordable 5 x 5 imaging array based on pin diode or avalanche photo diode technology. Include: (a) the technological approach used to develop the specified array; (b) the quantum efficiency and responsivity of each pixel element at 1.55 microns; (c) the gain and speed characteristics of each pixel over the DC to 2.0 GHZ bandwidth; (d) dark current and noise equivalent power (NEP) characteristics of each pixel element; and (e) signal processing and parallel processing interface issues, as well as high speed pixel clocking at one nanosecond rates. The end product will be a technical report describing the defined array and projected performance parameters.

PHASE II: Design, build and test an engineering demonstration model of the 5 x 5 array based on the concepts and parameters defined in Phase I for use in laser radar ranging and discrimination targeting systems.

PHASE III: Produce a production ready model (PRM)of the 5 x 5 detection imaging array to be integrated into Navy laser radar systems. Deliver the prototype detector array to the Navy.

COMMERCIAL POTENTIAL: Affordable and robust imaging systems for law enforcement applications and image recognition systems for automated manufacturing processes.

KEYWORDS: Detector Array; Pin Diode; Avalanche Photo diode; Laser Radar; Laser Radar Receiver; Eye-safe Target Identification

N00-020 TITLE: Obsolete Electronic Parts Automated Functional Replacement System

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PMA-280, Tomahawk All-U-Round

OBJECTIVE: An electronic component is said to be obsolete when its commercial availability becomes limited or vanishes. Because of rapid changes in technology and the length of the acquisition cycle, every weapon system will experience obsolescence during its lifetime. This costs the government millions of dollars to emulate replacement parts, redesign circuit cards, find alternative sources, or make investments in life-of-type buys. The objective of this SBIR is to identify and develop processes, techniques, and tools that will reduce the cost of replacing these obsolete parts.

DESCRIPTION: With the goal of reducing life-cycle cost, the government is interested in exploring the potential for developing an automated system for the design and manufacture of functional replacements for electronic assemblies that contain obsolete components. Such a system would characterize and model the functional performance of the electronic circuitry and automatically design a functional replacement using available parts. A complete approach will address the several levels and types of electronic assemblies including:

_ General integrated circuits (ICs) and application specific integrated circuits (ASICs)
_ Analog circuits
_ Digital circuits: both logic and signal processing functions
_ Hybrid circuits

The successful offerer will address the approach to handling all or part of the preceding circuit types. It will also provide an analysis that describes the cost advantage of this approach.

PHASE I: Provide an in-depth study characterizing the problem and proposed system solutions identifying key attributes and applicable technologies. Provide a detailed design study of potential system designs to include hardware as well as software algorithms necessary for full system integration. Provide a detailed cost analysis showing the cost advantage of this approach.

PHASE II: Demonstrate a prototype system that analyzes, models, and designs functionally equivalent circuit board sets to eliminate the need for unavailable parts.

PHASE III: Provide productized systems readily available for commercial sales.

COMMERCIAL POTENTIAL: Success through Phase III will provide a system which incorporates the tools, algorithms, and hardware required for design of functionally equivalent circuit boards to alleviate the problem of obsolete parts procurement. Applications are generic and this product could be used for sustainment and post-production support of any electronic system.

KEYWORDS: Obsolete Parts; HDL; Sustainment; Post-Production Support; Integrated Circuits; System Integration; Algorithm

N00-021 TITLE: Nitrogen Charging System for the Advanced Amphibious Assault Vehicle (AAAV)

TECHNOLOGY AREAS: Ground/Sea Vehicles

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: DRPM Advanced Amphibious Assault Vehicle

OBJECTIVE: Develop a lightweight, compact, high-pressure, nitrogen charging system that can charge the AAAV's Hydro-pneumatic

Suspension Units (HSU's) in the field.

DESCRIPTION: The AAAV has 14 HSU's that use nitrogen gas to create a spring force. The current system used to charge the HSU's is heavy and difficult to transport. A new charging system is required, for field maintenance, that is small and light enough to carry on the AAAV. Ideally, the charging system would not require bottles of nitrogen. The AAAV needs a charging system that has the capability to remove nitrogen directly from the atmosphere (purity similar to commercially available bottled nitrogen). The new system must be capable of charging an 80 cubic inch volume (at 70 ^{0}F) to 7,000 psi within 30 minutes (15 minutes preferred). It is desirable that the maximum system weight be less than 87 lbs. The charging system will use on-board vehicle power. Required maintenance and repairs to the charging system must be performed without the use of special tools. Electric (28 VDC @ 500 amp maximum) and hydraulic (3500 psi @ 50 gal/minute maximum) power is available from the vehicle. Use of electric power is preferred. The charging system must also have the capability to use bottled nitrogen, when available.

PHASE I: Conduct a trade study of current technology to determine the optimum balance of performance, size, weight and cost to meet the requirements stated above. Comments from government/military personnel in the AAAV office will be provided for the trade study. Develop a charging system design and document the expected performance.

PHASE II: Manufacture and test three charging systems. This effort will include a period of redesign between prototypes to incorporate design improvements based on government test and evaluation. The contractor will provide maintenance procedures and spare/repair parts for testing. The contractor will support system maintenance and repair during operation of the prototypes.

PHASE III: Prepare a manufacturing plan to produce the nitrogen charging system in quantity. Market the product to the military and commercial sector where nitrogen systems are used.

COMMERCIAL POTENTIAL: Can be used anywhere a low to high pressure nitrogen gas charge is needed. The use of nitrogen prevents oxidation/corrosion of internal components improving the reliability of the charged system. High pressure nitrogen is used in numerous military systems. Commercial applications include the auto racing industry and heavy construction equipment.

REFERENCES:
1. Engineering Design Handbook, Automotive Series Automotive Suspensions, 14 April, 1967, published by United States Army Material Command, pg. 1-22
2. Fundamentals of Vehicle Dynamics, Gillespie, T. D., Copyright 1992, published by Society of Automotive Engineers, pg.147-189

KEYWORDS: Tools, Maintenance, Nitrogen, High Pressure, Efficiency, Nitrogen Charging

N00-022 TITLE: Small, portable, lightweight, multi-fuel powered electric generators

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Sensors/Electronics/Battlespace

OBJECTIVE: Develop small, light weight (under 50 lb.), multi-fuel (diesel, JP-5, JP-8) capable electric generators with output in the 1 kW range.

DESCRIPTION: As military operations become increasingly dependent on C4I capabilities, there is increasing need for light weight electric power generators that are highly portable to meet both AC and DC power needs for small detachments operating in the field. Often the need is in the 0.5~1 kW range but for extended duration. With the one-fuel forward policy being implemented by the military, such units must be powered by diesel type of fuels. Presently, the smallest standard diesel powered generator in the military inventory weigh in excess of 300 lb. and is not suitable for portable use. The development of innovative concepts for small, light weight, multi-fuel capable generators that can be made available in the near term, at low cost is sought. The target weight for a fully packaged 1 kW unit is under 50 lb. The project will present some element of technical risk due to the size, weight, power constraints, however tradeoffs can be explored to mitigate that risk.

PHASE I: Develop concept based on near-term available technologies.

PHASE II: Develop and demonstrate a packaged prototype, one-man portable, light weight, diesel powered, 1 kW, 120 V single phase AC-generator.

PHASE III: Carry out manufacturing engineering to convert the prototype to production units with a variety of power and voltage levels with AC and/or DC output capabilities. Provide three units as deliverable for field testing and evaluation. Produce units in commercial quantities to military needs and expand into the commercial market to achieve further cost reduction to benefit military procurement.

COMMERCIAL POTENTIAL: Demand for small, portable, diesel generators exist in the commercial sector for home emergency power, recreational use at camp sites, and auxiliary power for motor homes and boats where the safety and stability of diesel fuel over gasoline represents a significant advantage. Additional needs include use on construction sites, for illumination of temporary road signs and at special events.

REFERENCES: Mission Need Statement for Command and Control Warfare, Cryptologic, and Signals Intelligence Systems number CCC11.21, dated 13 December 1993.
Operational Requirements Document for the Team Portable Collection System;
PSQ-9A (NO. INT 255.1.3) Dated 13 December 1995

KEYWORDS: Portable power, multi-fuel, diesel engine, generators, light weight.

N00-023 TITLE: Personnel and Material Tagging

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace, Weapons

OBJECTIVE: Provide operator the option of tagging (marking) personnel or equipment for future actions.

DESCRIPTION: The ability to non-lethally tag, or mark, personnel and equipment is desired for conducting military operations in urban terrain (MOUT) and other areas where immediate action is not appropriate. Such settings are challenging from a military perspective since there are many situations where immediate action would cause inappropriate collateral damage or unacceptable risk to the operators. The proposed technology solutions should be effective, non-lethal to personnel, and produce no permanent injury. The proposed technology solution should also not be easily countered. Delivery of the tagging device must also be addressed. The stand-off range for delivery must be at least 50 meters with an extended range of 500 meters or greater desired. The tag should be active with a range of at least one kilometer. Miniaturization is of importance, since one feature of this tag is covertness.
Tagging of enemy military equipment for targeting by a NLW at some later time is an example of how this technology could be used.

PHASE I: Determine candidate technology solution(s) and conduct initial testing to demonstrate potential for technology to: 1) non-lethally tag personnel and/or equipment, 2) be effective from ranges of at least one kilometer, and 3) be sufficiently small in size that it could be difficult to detect.

PHASE II: Demonstrate technology solution(s) against personnel and/or pieces of equipment. Develop conceptual delivery mechanism capable of delivering the technology solution(s) from at least 50 meters range.

PHASE III: Build prototype delivery system for technology solution(s) and demonstrate effectiveness of complete system against various personnel and/or pieces of equipment (vehicles, mobile machinery, etc.) from a range of at least 50 meters with >500 meters preferred. The tagging device delivered must be active with a range of one kilometer, and be small and covert once it is delivered to the target.

COMMERCIAL POTENTIAL: This system could be used by law enforcement agencies for marking personnel and/or equipment such as vehicles for future action. This would allow law enforcement the option of avoiding dangerous situations.

REFERENCES: Joint Non-Lethal Weapons Concept, Signed by LtGen M.R. Steele, Deputy Chief of Staff for Plans, Policy, and Operations, U.S. Marine Corps on 1/05/98, Available on World Wide Web at www.usmc.mil/nlw.

KEYWORDS: Tagging, Marking, Non-Lethal, MOUT

N00-024 TITLE: Position Location Tracking from Inside Building to Outside Building in an Instrumented Military Operations On Urbanized Terrain (MOUT) Environment

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop technology that will allow individuals to be tracked from inside a building to outside a building without losing contact in a MOUT environment. Additionally, this technology should track players located in areas in close proximity to building walls.

DESCRIPTION: In a MOUT environment there is a need to track individuals inside and outside of buildings. Tracking individuals outside buildings is normally accomplished by using GPS equipment. Tracking individuals inside a building is normally implemented by using an ultrasonic system. When an individual transitions from outside to inside the building the indoor tracking system acquires the individual instantly. Conversely, when an individual transitions from inside to outside the building the outdoor tracking system may take minutes to acquire the individual. This delay is unacceptable because the instrumented individual could have traveled over numerous meters while out of contact with the current tracking systems. Once GPS is acquired, the system can track the individual, but the history track between the time when the indoor tracking system lost contact and the outdoor tracking system (GPS) acquired the individual will be unknown.

PHASE I: Develop a design concept that can track an individual as the individual traverse from inside a building to outside a building without losing contact with the system. Additionally, the system should track individuals in areas outside of buildings where GPS cannot be acquired. The system shall have a tracking accuracy of one meter.

PHASE II: Develop a prototype system that can track an individual as the individual traverse from inside to outside a building without losing contact with the system. Extend the system to track a squad of instrumented Marines inside a MOUT environment as they traverse inside and outside buildings without losing contact the contractor shall demonstrate this capability.

PHASE III: Apply technology developed in Phase II to the Marine Corps Range Instrumentation System.

COMMERCIAL POTENTIAL: This system is applicable to any tracking system where individuals need to be tracked inside and outside of buildings. Use for SWAT training and monitoring prisoners are examples of likely commercial applications.

REFERENCES: Military Operations On Urbanized Terrain - Instrumentation System (MOUT-IS) Evaluation Report, Naval Air Warfare Center Training System Division Technical Report 98-016, November 1998

KEYWORDS: MOUT-IS, Indoor/Outdoor Tracking System, Position Location Tracking, GPS, Ultrasonic System

N00-025 TITLE: Wearable Operator Control Unit

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Initiate design of a comfortable, practical operator control unit for small Unmanned Ground Vehicle (UGV) Systems that minimizes intrusion and additional burdens placed on the system operator.

DESCRIPTION: Existing and emerging U.S.M.C. and U.S. Army Unmanned Ground Systems requirements address small robotic systems with minimal impacts on the load carried by soldiers and Marines. These requirements further desire that the operator be free to carry out other duties without undo hindrance from UGV equipment. The operator typically must remain free to perform other battle tasks while wearing and operating the control system.

PHASE I: Determine the feasibility, interfaces, architecture, and limitations presented by a wearable control system. An initial design concept would be delivered.

PHASE II: Develop and test a wearable Operator Control Unit by interfacing the system with at least one vehicle provided by the Unmanned Ground Vehicles/Systems Joint Project Office. Use of the Joint Architecture for Unmanned Ground Systems (JAUGS) will be required to enable the control unit to interface future vehicle systems as well.

PHASE III: Provide a rugged, reliable, militarily acceptable control system to address current and emerging requirements for Man-Packable and Medium UGVs for the Department of Defense.

COMMERCIAL POTENTIAL: This system could be applied to law enforcement as well as industrial inspection robot programs.

REFERENCES:
USMC Mission Need Statement for a Tactical Unmanned Ground Vehicle (TUGV); dtd 10 November 1993.
Operational Requirements Document for the Tactical Unmanned Ground Vehicle (TUGV); USATRADOC; dtd 16 August

1994;USMC dtd 7 May 1996.
Mission Need Statement for Special Operations Forces Micro Robotic Vehicle (SOMROV); USSOCOM; dtd 22 September 1997.
Operational Requirements Document for Outdoor Miniatures Robotic Ground Vehicle (OMRGV); USSOCOM; dtd 18 August 1998.

KEYWORDS: Unmanned; robotic; man-portable; wearable; control; ground.

N00-026 TITLE: Precision Sea-Based Logistics

TECHNOLOGY AREAS: Materials/Processes, Sensors/Electronics/Battlespace, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: DRPM Advanced Amphibious Assault Vehicle

OBJECTIVE: Develop, integrate, and test technologies for a Precision Sea-Based Logistics System that will allow automated tracking of spare parts, status of maintenance actions, cost accounting, prognostics, decision support system, and wire and wireless communication of this logistic data using universal, standard protocols.

DESCRIPTION: Precision Sea-Based Logistics is a critical aspect to Ship-To-Objective-Maneuver (STOM) and Operational Maneuver From The Sea (OMFTS). Total Asset Visibility (TAV) of spare parts; repair action notification and tracking; maintenance history; cost accounting; and prognostic evaluation is the key goal of this program.

Precision Sea-Based Logistics consists of a human-factored, computerized system located at centralized geographic locations. The system must be able to transfer and store reliability, maintainability, costs, and spare parts data. The system will allow spare part requisitions, maintenance requests, and fund transfers. TAV shall be maintained in the centralized database to include configuration management and maintenance history. These centralized systems shall be capable of wire and wireless communications with remote locations such as mobile vehicles (tank, boat, truck, etc) or maintenance facilities. The centralized systems maintain automated tracking of spare parts and status of maintenance actions performed on the mobile vehicles. The centralized systems also orders spare parts for the mobile vehicles, and schedules repair work at the maintenance facilities.

A Decision Support System (DSS) must be an integral aspect of the Precision Sea-Based Logistics. The DSS must filter vehicle data prior to the transmittal of such data either by wire or wireless.

PHASE I: Conduct a cost-benefit analysis to determine the most suitable technologies, both hardware and software, to employ. The technical feasibility and risks of existing and future technologies should be assessed. Develop a Precision Sea-Based Logistics concept with open system architecture to include the Decision Support System. Options and protocols for wire and wireless communication shall be identified. Develop a Performance Specification.

PHASE II: Fabricate and test one Advanced Technology Demonstrator to proof out the feasibility, operability, and suitability of the technology chosen from Phase 1. The contractor shall demonstrate the Advanced Technology Demonstrator in an operational environment. A test plan and test report shall be generated. The system shall be a open-architecture, low-cost design which allows incorporation into military and commercial applications.

PHASE III: Package and market the Precision Sea-Based Logistics System to the military and to commercial industry where Total Asset Visibility of its equipment is needed. Identify multiple, qualified vendors for commercial software modules used in the Precision Sea-Based Logistics system. Update the Performance Specification based on feedback from government and industry representatives. For military applications, have capability to interface with existing maintenance and supply information systems such as the USMC Asset Tracking for Logistics and Supply System (ATLASS), Small Unit Logistic Advanced Concept Technology Demonstrator (SUL ACTD), and MCWL Combat Service Support Operations System (CSSOS); US Air Force NALCOMIS; and U.S. Navy 3M and Integrated Condition Assessment System (ICAS).

COMMERCIAL POTENTIAL: The Precision Sea-Based Logistics System will have application to numerous military platforms and distributed commercial industries such as UHaul and UPS where Total Asset Visibility of its equipment is necessary.

KEYWORDS: Total Asset Visibility, Sea Based Logistics, Wireless Communication, Local Area Network, Reliability & Maintainability, Configuration Management

N00-027 TITLE: Link-16 Enhanced Positional Accuracy for Precision Guidance

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop a prototype software solution for providing munitions-quality positional accuracy suitable for Government and commercial applications.

DESCRIPTION: The Joint Services and NATO are currently, and will continue well into the 21st century, deploying Link-16 as the tactical data link in a variety of surface, air and subsurface platforms due to its robust (secure, high jam resistant) real time accuracy. The inherent Relative Navigation (RELNAV) capability of the Time Division Multiple Access (TDMA) architecture and synchronization process can be further explored to provide munitions-quality accuracy, thus providing a means of seamless end-to-end connectivity across a battlespace; for example, pilot to missile. Emerging network centric architectures would include smaller platforms, which are currently envisioned as solely relying on GPS for geopositioning, and are therefore vulnerable to satellite outage, jamming and spoofing. However, this research would initiate an innovative opportunity to complement or replace those GPS-reliant military and commercial applications. The time synchronous operation and high accuracy Time of Arrival (TOA) measurement capability of Link-16 data link terminals make possible the expectation that a higher performance navigation function will be achieved by a software only solution, thus requiring no hardware retrofit. The purpose of this SBIR is to identify, design and develop prototype innovative software solutions, using but not limited to the inherent theoretical principles of Link-16 and GPS, that show the most promise to achieve the desired positional accuracy for both military and commercial applications.

PHASE I: Identify and develop algorithms that show the most promise of improving positional accuracy to three meters or less Circular Error Projection (CEP). Demonstrate the viability of the algorithm(s), computer program interfaces and links.

PHASE II: Develop, test, and demonstrate under realistic conditions the most promising navigational algorithms. Carry out further validation, including certified laboratory and field testing of the developed software. Where it can be done economically, with non-SBIR funding, comparisons of the SBIR-tested algorithms with other available algorithms will be performed.

PHASE III: Apply software solution to Navy missile/weapon to demonstrate goal accuracy. Demonstrate the developed algorithm through simulation and then flight test.

COMMERCIAL POTENTIAL: From the outset this development must be keyed to multi-use applications - this imperative is driven by the need for interoperability and navigational coherency across military battlespaces, and is comparable to wide-area and metropolitan networks, regional and national enterprises such as FAA traffic control, and surveillance by FBI Coast Guard or Customs. This is needed wherever accurate, coordinated geolocation or navigation is required. Reduced size, weight and cost Link-16 terminals are presently being studied which would further open up an innovative application to industry in commercial air, transportation or any other system which presently utilizes GPS. The global capability of GPS and the real-time tactical capability of Link-16 RELNAV are complementarily attributes for both military and commercial applications. The potential capability and flexibility of the developed solution would allow its use for other commercial applications including precision landing systems, waypoint navigation, local and wide area coordination, and free flight cross-country navigation.

REFERENCES: "JTIDS RELNAV Redefined" by James L. Farrell and C. Gary Stephens

KEYWORDS: GPS; JTIDS; Link-16; Navigational; Relative Navigation; Precision Guidance

N00-028 TITLE: High Frequency Transmit Mast Clamp Current Probe

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop one or more low cost, low maintenance current probes capable of exciting various parts of a ship superstructure to act as a transmit antenna in the 2-30 MHz frequency range.

DESCRIPTION: The existing High Frequency (HF) antennas occupy substantial volume. This makes it difficult to find suitable installation locations that don't interfere with ship's operations (such as flight operations and weapons engagement) and don't cause performance degradation for this system and others because of physical blockage and Electromagnetic Interference (EMI). In addition the size and geometry of the existing HF antennas produce significant Radar Cross Section, thereby increasing the probability of the ship being detected and attacked.

PHASE I: Determine if there are magnetic materials for probe construction that can withstand the heat generated by multiple 1 kW transmitters and that can produce an impedance match to the structure over a broad band of frequencies. Determine the number of current probes required to cover the 2-30 MHz frequency range and the number of transmitters that can operate into each current probe.

PHASE II: Develop a prototype antenna(s) and measure its performance (EIRP, antenna pattern, linearity, inter-mods, isolation, EMI, etc.). Maximize performance while minimizing weight and volume. Antenna requirements are frequency range 2-30 MHz, VSWR 3 to 1, Omni-directional Antenna Pattern, polarization vertical, and 1 kW transmit power.

PHASE III: The current probe will transition to SPAWAR PMW179 to be backfitted on existing platforms and incorporated into new ships.

COMMERCIAL POTENTIAL: The current probe development is directly marketable to commercial and private vessels to provide low volume HF communications.

REFERENCES: Law, Preston, Shipboard Antennas, Artech House, Inc., Dedham, Mass. 02026, 1983

KEYWORDS: HF; Antenna; Whips; Topside; Communications; EMI

N00-029 TITLE: Jammer Placement Artificial Intelligence Tool

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop a modeling/simulation tool which would make intelligent decisions on optimal jammer resources to apply and where to apply them to a specified military scenario.

DESCRIPTION: Using digital maps including terrain propagation models as well as a data base of jammer resources, the user would specify criteria for GPS jamming levels in an area including areas where no GPS jamming would be desired. The modeling tool would select the most appropriate GPS jammer resources from a database menu and determine placement, power levels, and directivity requirements to meet the pre-selected jamming environment. An additional utility enables mission planning for jamming avoidance.

PHASE I: Develop an architecture approach identifying existing software tools, new software requirements, and software interface requirements. Demonstrate ability to model GPS in-band propagation in various terrains. Propose decision making software approach using artificial intelligence technology.

PHASE II: Develop necessary new software resources including artificial intelligence decision-making algorithms and integrate software. Refine decision making software and operator displays. Demonstrate prototype system in Fleet exercise and wargame scenarios.

PHASE III: Develop an efficient software package suitable for ruggidized PC execution. Incorporate data bases of Electronic Warfare assets as well as global terrain propagation and visualization software. Demonstrate utility in real time wargame/fleet exercise activities. Integrate tool in Navy shipboard workstations.

COMMERCIAL POTENTIAL: This tool could be used by DOT activities such as FAA as well as mobile communications systems in predicting impacts of interference on GPS and non-GPS wireless systems and communications and supporting corrective placement planning.

REFERENCES: Presidential Decision Directive 'U.S.GPS System Policy', March 1996

KEYWORDS: GPS, jammers, artificial intelligence.

N00-030 TITLE: Wireless Line-of-Sight Networks for IntraBattlegroup Communications

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop a wireless line-of-sight network capable of communicating at high data rates with up to 20 mobile platforms (..i.e, ships, submarines, etc.) and shore sites.

DESCRIPTION: The U.S. Navy is in need of a means of high data rate line-of-sight (LOS) communications between its ships, submarines, and shore sites. The Radio Frequency (RF) wireless network is characterized by a dynamic topology consisting of up to 20 mobile platforms (potentially more if airborne platforms are used). The communications should be robust to node outages (due to adverse propagation effects) and not rely on a single central controller. The wireless LOS network should be self-configuring and determine the optimum relay nodes (to extend the LOS communication ranges) without user intervention. The topology is commonly referred to ?ad hoc? in that all platforms are mobile. In addition, the communications should be robust to multipath fading and interference.

The wireless LOS network is to be implemented and tested in the AN/USC-61 Digital Module Radio (..see SPAWAR PMW-179 for additional information). Thus, this development will primarily be software for use in software programmable radios being built by the DOD. In addition the software should be portable to Joint Tactical Radio Systems (JTRS) which have hardware capable of supporting this wireless LOS network. Consideration should also be given to the use of these waveforms and protocols by joint forces (these applications could involve 100s of mobile platforms requiring multiple RF channels and/or a hierarchical wireless networking approach).

PHASE I: It is anticipated that this phase will define the physical, link, and network level protocols to be implemented. All protocols and waveforms will be simulated extensively in high level software (preferably using the ?C? language) in scenarios common to the U.S. Navy. This includes defining the intended operating frequencies and bandwidth for both Military and Commercial applications. In addition, Phase I will map these protocols into the AN/USC-61 Lowest Replaceable Units (LRUs), conduct a load balance on the individual processors, determine which algorithms require implementation in Field Programmable Gate Arrays (FPGAs), and determine the software constructs required to proceed with the implementations in DMR and JTRS. Deliverables will be a report describing the protocols and waveforms and their performance and the Phase II method of implementation. The report will also highlight those modifications required (if any) between the military and commercial variants.

The design of the wireless LOS network will at a minimum address the following specifications:
Support COTS Internet Protocols (..i.e, Transmission Control Protocols (TCP), User
Data Protocol (UDP), etc.) and multicast protocols
Allow for easy connection to external COTS routers

- Support User throughputs of at least 256 Kbps with round-trip latencies of less than 300 milliseconds
- Must have flexible operating frequency capabilities for military purposes in common U.S. Navy VHF and UHF frequency bands

PHASE II: Migrate the ?C? language software developed in Phase I into the AN/USC-61 Digital Modular Radio for implementation and testing. SPAWAR PMW-179 will assist with this phase by supporting the DMR vendor designated to assist the SBIR vendor in helping with integrating this new capability into the DMR and its Human Computer Interface so that it does not disrupt the existing operational modes of DMR. Testing will be conducted to assure accurate operation. The software will be ported to at least four DMRs to allow for wireless LOS network testing (laboratory and limited over-the-air).

PHASE III: Perform operational testing in a complete Aircraft Carrier Battle Group and/or Amphibious Readiness Group including at least 6 mobile platforms. If these tests reveal any deficiencies in the waveform or protocols, they will be improved and the wireless LOS network waveform will also be tested in other radios that are JTRS compliant, possibly tested in a joint operations.

COMMERCIAL POTENTIAL: The ‘’Wireless Line-of-Sight Networks for IntraBattlegroup Communications’‘ has outstanding potential to address commercial applications in compliance with SBIR funding ‘’dual-technology’‘ attributes.Commercial applications include mobile Users operating without existing infrastructures such as warehouse operations, fire and police field work, emergency relief backup and third world countries surveying.

REFERENCES: DMR Performance Specification, SPAWAR-D-900, 5 July 1998, DMR AN/USC-61 Primer, 15 March 1999

KEYWORDS: Wireless LOS Networks, Intra-Ship Communication Networks, RF Wireless Networks, and HDR LOS

N00-031 TITLE: <u>Sensor Tasking Segment (STS)</u>

TECHNOLOGY AREAS: Information Systems, Sensors/Electronics/Battlespace

OBJECTIVE: Develop common network-centric tasking software segment for managing and controlling Information Warfare (IW) sensors and countermeasure resources across the shipboard, battle-group, theater, and national IW environments.

DESCRIPTION: Present IW sensor systems have different tasking software and displays, each designed to control front-end receiver and the signal processing resources for the system. These systems have cooperative overlap in spatial, frequency coverage and capabilities not only within the battlegroup but also with national and joint partners. The precise mix of systems will depend on the mission assigned and the Major Regional Conflict (MRC) that the mission is assigned. Currently, each system is tasked and operated independently. What is lacking is a scalable tasking environment that will optimize the information collected by synergistic systems. Moreover, a carrier battlegroup consists of a number of ships, each with its own set of sensor, geolocation processing and countermeasures subsystems. These collective subsystems do not fully satisfy modern Information Operations requirements when deployed in battle groups in theater with national resources. The STS will be designed for network-centric operation and will control the following: (1) the radio frequency distribution unit; (2) interference mitigation resources; (3) the intercept receiver search strategies; (4) detection, ID, and recognition resources; (5) copy processors; (6) geolocation; (7) countermeasures and (8) results reporting. Sensor tasking can come from the following sources: signal recognizers, system operator, other own ship systems, STS?s on other ships within the battle group, theater and national sources. STS?s can task sensors up to the national level. Real-time response is required for own ship and in near real time within the battle group.

Depending on priority, the system will handle three types of tasks from sources: automatic, automatic with operator initiation, and manual. Initiation and the result of tasking will be communicated among and shared with any STS on the network with control. More than one STS makes up a ?distributed, collaborative? management system. In the case of multi-ship tasking and upon request, each STS will provide the requesting STS the following: resource availability projected reporting times, estimated performance (such as hearability and DF accuracy), etc. Negotiations using priorities will determine use of the resources. Data link availability, delays and capacity will also be monitored and managed with priorities.

The STS will be a GCCS-M software segment within the cryptologic unified build (CUB). If feasible, the software should be commercial-off-the-shelf (COTS) to the largest extent possible. It is anticipated that much of the software development will be in the form of application program interfaces. These interfaces should be object oriented, agent based, transportable and flexible. The software should be scalable and reconfigurable to the extent necessary to interface with diverse IW sensor and countermeasures resources. It is important that a cost and performance versus architecture/resources analysis be performed early to establish the cost-effectiveness of the system.

PHASE I: Create an initial software architecture and cost/performance vs. architecture/resources study. Identify COTS products that provide significant development savings; identify their risks. Identify, cost, and prioritize risk of development software modules.

PHASE II: Implement and demonstrate the operation of three STS software systems operating via ether net (wideband) and telephone (narrowband) networks.

PHASE III: Design a full scale STS including interfaces. Test at sea with multiple ships.

COMMERCIAL POTENTIAL: The produce being developed here is useful for any company that needs a real-time, distributed, management system. Systems associated with communications and transportation, which are distributed across large areas, require some sort of real-time control. Companies that must coordinate the manufacturing of many components to meet system integration deadlines require distributed, real-time control.

KEYWORDS: IW Sensor Management; distributed; collaborative; network-centric; controller; tasking

N00-032 TITLE: <u>Automated Network Anomaly Detection and Fault Tolerance Toolkit</u>

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop a toolkit that utilizes Modeling and Simulation (M&S) to facilitate the study of intelligent agents for the automation of network anomaly detection and fault tolerance in mobile, multi-media environments.

DESCRIPTION: Recent investigations of intelligent agents have shown the feasibility of proactively identifying anomalous network activity and predicting network faults in simple local area network environments. These studies use experimental network data and test cases to evaluate the performance of specific intelligent agents. This effort would utilize M&S to study the composition of intelligent agents and their performance over a variety of network conditions and failures which include wireless problems in Navy and commercial mobile networks.

PHASE I: Develop a design for an Automated Network Anomaly Detection and Fault Tolerance Toolkit that facilitates the study of proactive identification of network faults and outages. The design should illustrate the feasibility of modeling network failure characteristics, network performance measures, and algorithms that predict failures from available performance measures in multi-media environments.

PHASE II: Develop and test the Automated Network Anomaly Detection and Fault Tolerance Toolkit for use in the optimization of multi-media networks. Utilize actual network data to provide validation and verification of the toolkit performance.

PHASE III: Develop a user friendly interface and documentation that provide users in military and civilian environments with proper toolkit instructional information.

COMMERCIAL POTENTIAL: This toolkit could be utilized by equipment vendors, system integrators and system maintenance personnel to optimize automated fault tolerance procedures in network environments. The toolkit could be used to assist in the development of proactive fault tolerance algorithms for commercial and custom network devices and systems.

REFERENCES: M. Thottan, C. Ji, Proactive Anomaly Detection Using Distributed Intelligent Agents, IEEE Network, September/October 1998.

KEYWORDS: Agent, automation, mobile, modeling, network, simulation

N00-033 TITLE: Trusted Workstation Using a Plug-in Encryption Module

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Demonstrate that a trusted workstations equivalent to a B-1 Compartmented Mode Workstation (CMW) can be built from a COTS PC using a plug-in hardware module.

DESCRIPTION: Many Naval systems would be easier to design and develop if specific workstations (WSs) could be trusted to maintain separation between information of various sensitivities, compartments or classifications. Such a WS needs to maintain its MLS (Multi-Level Security) capability through hardware and software failures and through attempts to defeat security via external connections (external threats) and via unauthorized users (insider threats). Without the ability to maintain separation at the WS, it is usually necessary to install, maintain and support separate LANs at the appropriate sensitivity levels. For instance, Navy ships typically maintain Unclassified, Secret, and SCI LANs. Commercial companies often have separate LANs providing separation for company-restricted information. In addition to the cost implications of redundant systems, there is often a significant operational penalty since some of the information on the separate systems must be shared. Some MLS capability has been developed using UNIX CMWs based on specific hardware platforms and trusted operating systems evaluated to meet Orange Book B-1 level criteria. However, the attendant restrictions on hardware and software are both a cost driver and a significant limitation to evolutionary system upgrades.

PHASE I: Pick a representative CMW application. Compare the expected security of a COTS PC (with plug-in security module to enforce WS security) to the security achieved using the CMW. The evaluation should be performed by the contractor using normal certification processes under the guidance of a Navy Certification Agent (CA) or team. Develop a Phase II work plan to the CA's satisfaction that would demonstrate equivalent WS/CMW assurance (for the selected application) through analysis and testing.

PHASE II: Build at least one COTS PC WS running unmodified Windows 95 (or later Microsoft OS) with plug-in security module and demonstrate that the resulting WS can meet equivalent CMW security requirements and can transparently run unmodified application programs.

PHASE III: The contractor will work with a Navy project team to demonstrate a specific MLS application running on the resulting WS. Depending on the contractor's marketing strategy, Phase III could also be used to obtain formal evaluation per the Common Criteria.

COMMERCIAL POTENTIAL: The resulting WS would be an attractive solution to a variety of commercial systems that have similar MLS requirements. However, since the WS would be functionally equivalent to other PC WSs used at government or industry sites, it could replace PCs at any seat that need greater assurance for security-related functions (e.g. access control; protection of stored programs, data or files; misuse detection; or protected communication with other stations). The high assurance provided by the workstation enables the provision of these additional security functions by the SBIR contractor or by 3rd party vendors. The potential market, therefore, is for tens of thousands of WS modules and for the add-on security products (both software and hardware).

KEYWORDS: Multi-Level Security; High Assurance; workstation; secure terminal; computer security; trusted computer

N00-034 TITLE: Wideband Radio Frequency (RF) Distribution System

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop an RF distribution system based on a scaleable/open system architecture, which is capable of operating over a potential frequency range from HF-UHF to support Communications and Information Warfare system (attack & exploit) requirements. This topic will lead to the development of a new Radio Frequency Distribution System (RFDS) that can satisfy both modern C4ISR communications and Information Warfare future goals & requirements.

DESCRIPTION: Present shipboard communications and Information Warfare systems use separate RF Distribution Systems between their respective antennas and transmitters/receivers that is based on 1960s RF technology. While a number of advanced technology programs have addressed the technical issues and design associated with combining topside antennas for modern communications and IW requirements, none have addressed the technical challenges associated with the application of advanced technology toward the design of an RFDS for Communications and IW in the frequency range of HF through UHF. Today's shipboard operations may include10 transmitters and 50 receivers operating in this frequency band simultaneously (albeit with different multicouplers, RFDSs, and antennas). The goal of this topic is to explore and apply advanced RF technology and open architecture to solve the technical issues associated with combing the functions of existing multicouplers, RFDS, RF filters, etc. to greatly enhance the shipboard capability to conduct modern communications and network-centric warfare. To satisfy present and future RFDS requirements, the RFDS must be capable of interfacing a number of shipboard HF thru UHF transmitters, receivers and antennas covering the frequency range with the flexibility to change configurations in milliseconds. The RFDS must be capable of accommodating broadband signal distribution to allow spread spectrum and frequency hopping communication and counter-communications (IW) operations. As a minimum, the technologies investigated should include high dynamic range and high speed/low loss/EMI inhibiting switching (potential technologies include optics and cryogenics), extremely wideband RF component and circuit design, sharp response filters and couplers (potential technologies include ferrite's and cryogenics), extremely low loss/linear/phase controlled transmission lines (potential technologies include optics and cryogenics) and extreme EMI management control (potential technologies include hopping filters, cancelers, excision and signal extraction).

PHASE I: This phase consists of examining present typical shipboard RF configurations for transmitting and receiving information through existing RFDSs for communications and IW (signal exploitation and counter-communications) in the HF through UHF frequency range. Based on current and advanced RF technology, conduct technological tradeoffs to determine the range of enhanced performance achievable, the degree common functions can be combined and possible basic RF design schemes. The tradeoffs must address technical risk.

PHASE II: Based on the selected basic RFDS design, complete a detailed design. Prototype and prove out key elements of the design where significant performance risk is known to exist. After identifying the technical risk associated with the design and critical RF component selection, conduct a critical design review (CDR). Following the successful CDR, build and test a prototype RFDS. The prototype testing must include a shipboard proof-of-concept feasibility demonstrations. The RF Distribution System will be developed for compatibility with shipboard communications, Cooperative Outboard Logistics Upgrade (COBLU) Phase 1, Ships Signal Exploitation Equipment (SSEE) (both PMW 163 systems), Lighthouse/AN/USG-146 (PMW 162 IW exploit/attack systems) and the Joint Tactical Radio Systems (JTRS). The latter would enable its use by all agencies of the DOD.

PHASE III: The design achieved in Phase II has numerous commercial applications where transmitters and receivers share common antennas and signal sources; e.g., Immigrations and Naturalization, Drug Enforcement Agency, Highway Patrol, Ship-to-Shore communications, commercial shipping, dispatchers, and extensive foreign sales opportunities. For the Navy, this phase would consist of manufacturing sufficient numbers of production versions of the RF Distribution System in order to demonstrate the operational viability and effectiveness of the unit. In addition, upon satisfactory completion of shipboard installation and operational testing , the RF Distribution System project would transition to the standardized process of Fleet introduction and general incorporation into both new construction and backfit modernization programs.

REFERENCES:

· DMR Performance Specification, SPAWAR-D-900, 5 July 1998, DMR AN/USC-61 Primer, 15 March 1999
· COBLU Phase 1 Functional Description Document, CDRL B00D, February 1999 (CONFIDENTIAL)
· Functional Description Documents for Lighthouse, AN/USG-146, SSEE, JTRS & (High Frequency Radio Group) HFRG
· MRFDU Technology Survey & Specification, September 1999, Eldyne/Titian

COMMERCIAL POTENTIAL: The "Wideband RF Distribution System" has outstanding potential to address commercial applications in compliance with SBIR funding "dual-technology" attributes. Commercial applications include the wireless distribution of a wide range of electromagnetic signals, including: direct broadcast (satellite) television systems, cell phone services, and personal communication systems (PCS), which utilize terrestrial, geosynchronous and low earth orbiting (LEO) satellite signals. The potential customers include the general population of private mobile users and their suppliers, and commercial entities such as internet service providers, point-of-sale terminals, and corporations and small businesses involved in the emerging fields of electronic commerce.

KEYWORDS: Radio Frequency, Direction Finding, Precision Geolocation, RF Distribution Systems, Wireless Networks, Inter-Ship Communication Networks, RF Wireless Networks, HDR LOS, IW RF Management, RF Controller, and EMI/RFI.

N00-035 TITLE: High Precision Depolarized Fiber Optic Gyro (DFOG)

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Strategic Systems Program Office

OBJECTIVE: Develop and demonstrate a method for achieving a factor of 10 random noise suppression for depolarized fiber optic gyros above and beyond that which can be achieved using an operating bias point near the dark fringe. The noise reduction method cannot substantially degrade bias performance of the gyro.

DESCRIPTION: It is well known that the Angle Random Walk (ARW) of a fiber optic gyro limited by source intensity noise can be reduced by choosing an operating bias point near the dark fringe.* It is highly desirable to further reduce the ARW. Source noise subtraction/compensation schemes have been developed for polarization maintaining fiber gyros. However, such schemes have not been demonstrated to be highly effective on Depolarized Fiber Optic Gyros (DFOG) utilizing low cost single mode fiber. In order to demonstrate the feasibility of using such a DFOG design for the SSBN Navigation application, it will be necessary to develop and demonstrate a method for achieving a factor of 10 random noise suppression for the DFOG above and beyond that which can be achieved using an operating bias point near the dark fringe.

PHASE I: Perform a study, analysis and simulation of candidate methods for depolarized IFOG ARW reduction. Select the best approach and develop a practical design that can be evaluated on a depolarized IFOG in Phase II. Provide an error budget showing the predicted ARW achievable in _rad/_hz.

PHASE II: Fabricate a depolarized FOG and run tests to evaluate the error sources in the error budget and demonstrate the ARW reduction. Provide a test report documenting the test results and verification of the error budget.

PHASE III: Design, fabricate, test and deliver low cost depolarized FOGs for various military applications utilizing the noise reduction approach demonstrated in phase II. If successful, this development would transition into the SP24 Navigation Sustainment Program.

COMMERCIAL POTENTIAL: Low cost FOG's with very low ARW have commercial application where very accurate pointing stabilization is needed. One example is in the area of high precision robotics.

KEYWORDS: Fiber Optic Gyro; FOG; Rotation; Sensor; Angle Random Walk; Random Noise Suppression

REFERENCES: Lefevre, H.C. et al., Proceedings of the SPIE, Fiber Optic Gyros, 10th Anniversary Conference, Vol. 719, September 1986, pp.103.

N00-036 TITLE: MicroElectroMechanical Systems (MEMS) for Ordnance Monitoring

TECHNOLOGY AREAS: Materials/Processes, Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Strategic Systems Program Office

OBJECTIVE: Develop and demonstrate a MEMS integrated sensor, analyzer, and data management device and data collection/reporting system for energetic component sampling and assessment to support program and user planning and decision making during all phases of weapon system life.

DESCRIPTION: The chemical stability of energetic components is one of the primary limitations of fielded ordnance systems. Programs establish conservative environmental and service life limits to ensure both performance reliability as well as ordnance safety. Investigations of age-related performance degradation indicate that energetic components are sensitive to environmental factors through life and have resulting significant variance in service life. Precise monitoring of environmental conditions as well as the chemical state of degradation products provides the capability to significantly extend ordnance component service life. Current methods for environmental condition monitoring and chemical state assessment are expensive and influence program schedules. In addition, current methods require significant system intrusion with potential safety and availability impacts and make use of scarce and high cost resources. The insertion of low cost, high reliability monitoring technology directly into produced energetic components will provide monitoring and assessment capabilities enabling potential high-payoff life extension decisions. Approaches employing MEMS have been identified as having strong potential for low cost and high reliability energetic component monitoring. This effort will require both development of a MEMS sensor and preprocessing device as well as a data collection and communications method for real-time, on-board/on-site and off-line, remote assessment requirements.

PHASE I: Perform an application detail study, analysis, laboratory test and simulation of candidate MEMS methods for energetic component performance and material condition assessment. Reference 1 provides an overview for this application. Identify trade-offs and combinational strategies between current methods and use of embedded MEMS devices. Apply current findings of on-going DOD aging and surveillance efforts to plan advanced developments of a MEMS monitoring device. Since the effort will integrate MEMS with existing gas generators, the notional gross specifications for MEMS should follow the current gas generator specification, reference 2, as amplified below.

Specifications and Salient Characteristics:
1. Monitored Equipment: gas generator per reference 2.
2. Monitored Propellant type: double base EDD-2 per reference 2.
3. Notional MEMS population: three to twelve per gas generator assembly
4. MEMS Long Term Temperature range: -20 deg F to 180 deg F
5. MEMS peak firing pressure and time: 4000 psig, 1 sec
6. MEMS Pressure range: -10 psig (neg) to 250 psig
7. MEMS Humidity range: 0 to 100% RH
8. MEMS Immersion rated to 15 psig
9. Monitoring periodicity: quarterly over 10 year period or semiannually over 25 year period
10. Acidity: to pH 4
11. Organic Solvents: full resistance to methanol, ethanol, acetone, acetic acid, and nitroglycerin
12. Monitored conditions:
12.1 REQUIRED: temperature, pressure, humidity, presence and concentration (%) acetic acid (in gas phase)
12.2 DESIRED singly or in combination: (in gas phase) free trinitroglycerin, 1,3-dinitroglycerine, 1,2-dinitroglycerine, 2-N-nitrodiphenylamine (2-NDPA), 2-NDPA daughter products or derivatives (N-NO-2-NDPA, N-NO-2,4DNDPA, N-NO-2,4'-DNDPA, N-NO-2,2'DNDPA, 2,4-DNDPA, 2,4'-DNDPA, and 2,2'-DNDPA) (in solid or liquid phase) free nitroglycerin, 2-N-nitrodiphenylamine (2-NDPA), 2-NDPA daughter products or derivatives (N-NO-2-NDPA, N-NO-2,4DNDPA, N-NO-2,4'-DNDPA, N-NO-2,2'DNDPA, 2,4-DNDPA, 2,4'-DNDPA, and 2,2'-DNDPA), Potassium Sulfate (non-chemistry) shock (triaxial, peak), vibration, firing pressure (P) and time to peak P
12.3 REQUIRED: Special functions: track and store gas generator data - procurement specifications, serial numbers, cast location, cast date, assembly date, shipping history (date, shipper, recipient), storage location records (site and date), installation records (location, install date, remove date), firing records (date expended)

PHASE II: Fabricate a launch tube gas generator monitoring device and run tests to evaluate cost and reliability. Provide a test report documenting the test results and verification of safe device operation. Compare results between MEMS monitoring and current methods.

Specifications and Salient Characteristics:
1. MEMS detect and classification for type and concentration of stabilizer and stabilizer daughter products is within 5% relative of referenced standard laboratory (HPLC, GC, or GPC) tests for all required species.
1.1 MEMS monitor and record propellant head space temperature, pressure, and humidity within referenced specification requirements on periodic basis.
1.2 Transmit stored data to weapon system information network on demand via high reliability modality.
2. Demonstrate intrinsically safe technology to support ordnance safety.
3. Demonstration of multiple cooperative MEMS units within one gas generator to meet redundancy and functional requirements.

PHASE III: Design, fabricate, test and deliver low-cost, embedded energetic component monitoring devices for various military applications utilizing the strategies and approach developed and demonstrated in phase II. If successful, this development would transition into the SP22 Launcher Sustainment Program; and potentially to warhead and rocket motor monitoring of all weapons systems, and commercial chemical manufacturing, storage and transportation facilities.

Specifications and Salient Characteristics:
1. Specification life: 10 years (removable), 25 years (non-removable)
2. Meet reference 2 requirements for service conditions.

COMMERCIAL POTENTIAL: Low cost MEMS for energetic component monitoring have widespread commercial application where fuels and explosive product quality monitoring is required. One example is in the production, storage and transportation of hazardous materials.

REFERENCES:
1) STRATEGIC APPLICATIONS of MICROELECTROMECHANICAL SYSTEMS (MEMS) By LCDR Gary W. Sweany, USN

Program Management Office, Strategic Systems Programs, PO Box 391537, Mountain View, CA 94039 ,June 1999
2) WS23136 Amendment I, Critical Item Production Fabrication Specification for Propellant Actuated Gas Pressure Generator, MK74 MOD1
3) Yazdi, Navid, "Micromachined Inertial Sensors", Proceedings of the IEEE, Volume 86, Number 8, August 1998.
4) Stark, Brian, "MEMS Reliability Assurance Guidelines For Space Applications", JPL Publication 99-1, Jet Propulsion Laboratory, Pasadena, CA, January, 1999
5) Tang, William C., "MEMS Applications in Space Exploration", SPIE Vol. 3224, 1997.
6) Gardner, Julian W., Microsensors Principles and Applications, John Wiley and Sons Ltd, West Sussex, England, 1994.
7) MEMS, Sabrie, Solomon, McGraw Hill, June 1999 (new publication)
8) Chemical Microsensors and Applications, Proceedings of the SPIE, Conference 3539, November 1998, Vol. 3539

KEYWORDS: MEMS; ordnance; energetic; life extension; safety; Condition Based Maintenance

N00-037 TITLE: Global Positioning Satellite (GPS) Receiver Test Bed

TECHNOLOGY AREAS: Space Platforms

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: Strategic Systems Program Office

OBJECTIVE: Develop a dynamic simulation of GPS signals from the antennas on the Trident II reentry body (RB) so that the performance of various GPS receivers can be assessed relative to Trident requirements.

DESCRIPTION: The cost of determining the performance of various GPS receivers under actual dynamic RB ballistic conditions is prohibitive. A cost-effective alternative is the use of simulation to create equivalent signals as from the antennas of an RB, as it would transition through the different environmental regimes. Conditions which must be simulated include RB position and orientation as it moves, precesses and nutates relative to the GPS constellation; endo-atmospheric plasma and atmospheric attenuation and noise; and aerothermal coupling. The computer model of vehicle motion will provide vehicle position and angular coordinates as inputs to the GPS signal simulation. Based on these inputs, the GPS signal simulation will generate simulated signals from the reentry body's antennas. The simulation will then provide the appropriate signals to an actual GPS receiver. The GPS receiver, such as a Magellan 5000 PRO, will furnish positional coordinates to the computer model of vehicle motion via an interface such as an IEEE 488. A comparison can then be made of the RB position and its GPS indicated position to note GPS receiver performance. The SBIR is comprised of the computer model of vehicle motion, the GPS signal simulation, the interface between these two models, and the output interface from the GPS receiver. A third interface from the GPS signal simulation to the GPS receiver is commercially available. All motion and IMU modeling will be carried out on a PC using an Intel Pentium III with Windows NT operating system.

PHASE I: Perform a preliminary design of the simulator/receiver and demonstrate feasibility including how body position, velocity, acceleration, antenna-obscuration etc. alter the simulated GPS RF signal.

PHASE II: Develop a prototype of the GPS signal simulation which will accept as input vehicle dynamic descriptors (e.g. vehicle angular velocity and acceleration). Interface a commercially available GPS receiver, which in turn will provide a stream of navigation coordinates via a standard interface. The contractor must document all work performed under this program.

PHASE III: Design, fabricate and test a GPS receiver test bed that is suitable for use in commercial satellite launches where precise placement in low earth orbit is critical.

COMMERCIAL POTENTIAL: The specific application of the innovation is in the modeling of very accurate dynamic vehicle paths. However, commercial application of an interactive GPS simulation with navigator (receiver) in place are extensive. The most obvious use is in the testing of proposed receivers (and their navigation algorithms) in an environment that is far more exhaustive than can be achieved by a single channel bench test signal. Interactive simulations, such as suggested in this work can easily find broad application to marine, aeronautical or terrestrial platforms, particularly those in a high dynamic environment e.g. ships in high sea states or vehicles traversing irregular terrain at high speeds.

REFERENCES:
1. Hatch, R. "The Synergism of GPS Code and Carrier Measurements", Proceedings 3rd International Geodetic Symposium on Satellite Doppler Positioning", Vol. 2, Feb 8-12, 1982
2. Lohnert, E. B. Eissfeller, O. Wagner, "Analysis of a Completely Integrated INS/GPS Navigation System for Re-entry Vehicles", Institute for Geodesy and Navigation, University FAF Munich, Germany

KEYWORDS: GPS; GPS Simulator; Global Positioning Satellite; Re-entry Body; Re-entry Vehicle; Navigation

N00-038 TITLE: Robotic Manipulator for Cargo/Weapons Handling

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop ultra-high capacity robotic system for moving palletized and containerized weapons and cargo aboard ship.

DESCRIPTION: Conventional cargo/weapons handling requires fork trucks to move loads to and from their stowage locations and the vertical conveyances. Fork trucks and pallet movers require personnel to operate and maintain and valuable deck space to maneuver and stow. Oversized elevator door openings are required to accommodate the fork trucks and safety devices are required to prevent the fork trucks from entering an open elevator trunk. Fork trucks put undue stress on the elevator when they are driven onto the platform and create an additional safety hazard when operated in congested areas during material handling operations. The reduction or elimination of fork trucks in cargo/weapons handling would improve the efficiency of those operations and ships' operations in general. The manning reductions mandated for future ship classes demands the development of robotics or other automation technology to replace personnel in shipboard cargo/weapons handling operations. The objective of this project is to develop a system wherein robotic manipulators are positioned to any stowage location in a magazine or cargo hold, lift the load and deliver it to the elevator platform and vice versa. This project coincides with SBIR topic N99-117 "Linear Motor Technology in the Vertical Plane". The objective of N99-117 is the development of a ropeless, linear motor driven elevator system that uses multiple, independently moving platforms capable of vertical and horizontal motion. The combined objective of N00-0S2 and N99-117 is an advanced shipboard cargo/weapons handling system capable of faster, smoother and more efficient material flow than the existing system while facilitating the proposed manning reductions. This project also coincides with, but is not redundant to SBIR topics N98-108 Grabber for Ordnance Handling Robot and N98-109 Control Approach for Heavy Payload Handling Robots. Technology developed under topic N98-109 could be leveraged for control of the hardware developed under N00-0S2. N98-108 developed a grabber for handling individual rounds vice palletized rounds. Topic N98-113 addresses manipulators, but for small payload manufacturing processes for the Marine Corps, not high capacity cargo/weapons handling aboard ship. There has been no known research and development of a robotic system with the power density necessary to manipulate payloads of this size within the confines of a space similar to a standard hold or magazine aboard a U.S. Navy ship.

PHASE I: Develop concept proposal for robotic manipulation of weapons and cargo aboard ship. Conduct a study to determine the power density and electromechanical needs necessary to deliver and retrieve containerized and palletized loads of up to 6,000 lbs. between elevator platform and stowage location under dynamic sea state conditions. A system capable of lifting, articulating, moving horizontally and lowering its payload within the confines of a hold or magazine similar to those aboard current ship classes is most desirable. Present findings with data, illustrations, related work, etc. to demonstrate feasibility of robotic manipulation of palletized and containerized loads aboard ship. Discuss any unique requirements relative to current shipboard configuration and stowage methods. Explain concepts and components to be used for phase II.

PHASE II: Develop a model, scaled in size and capacity of a system consisting of robotic manipulator(s) with end effector(s) and positioning system capable of handling an equivalently scaled standard pallet and container. The manipulator(s) must be capable of articulating as necessary to reach into a simulated elevator opening to deliver or retrieve the load, lift and move the load horizontally both forward/aft and port/starboard, lower and stack loads. Model must be sized to facilitate mounting on a ship motion simulator.

PHASE III: Develop a full scale land based test site for the testing and evaluation of robotic manipulators, end effectors, positioning devices and control for use in shipboard cargo/weapons handling. Test site will include current generation of shipboard capable robotic devices designed as a result of this project. Test site will be designed so as to facilitate change out of manipulators and positioning devices as different units are tested and future generations of robotic devices are developed.

COMMERCIAL POTENTIAL: Technology developed through this project can be applied to land based material handling applications such as manufacturing, construction and warehousing as well as the commercial shipping industry.

REFERENCES: Introduction to Robotics, Arthur J. Critchlow, MacMillan Publishing Co.

KEYWORDS: robotics, handling, manipulator, cargo, material, weapons

N00-039 TITLE: Advanced Fuel Filtration

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Human Systems

OBJECTIVE: Demonstrate an aviation fuel filtration system with a 4000 gallon per minute (GPM) capacity (double the current capacity) at a weight and volume that is half that of the current system aboard aircraft carriers.

DESCRIPTION: Future aircraft carriers will be required to project considerable more force than is capable today. This is exemplified by the sortie rate requirements in the CVNX Operational Requirements Document (ORD). The CVNX ORD dictates a surge sortie rate objective of 300 sorties per day, a 50% increase on anything carrier aviation has demonstrated to date. A key factor to achieving this faster tempo of operations is ability to fuel aircraft at a faster rate. The maximum rate at which the carrier can deliver aircraft-quality fuel is 200 GPM, even though most aircraft can receive fuel at a much higher rate - over 400 GPM. Pumping fuel at 400 GPM would help the Navy meet the sortie rate objectives that future ships will demand.

A critical limiting factor to increasing fuel flow rate is the fuel filtration system. Presently, fuel is serviced to aircraft via 2000 GPM filter vessels to 20 refueling stations on the flight and hangar decks. There are 4 filter vessels on the ship, 2 forward and 2 aft. Each vessel weighs 10,500 lbs dry and 22,500 wet and has a volume of 340 cu ft (95 in x 79.5 in x 78 in). This system is necessary in order to meet the stringent aircraft engine manufacturers' requirements for fuel quality: no more than 5 parts per million (PPM) of water and 2 mg/l of sediment.

Each of the current vessels houses 134 coalescer elements, 58 separator elements and a rotary control valve for automatic water removal. Changing of the elements, which at a minimum is a 12 hour job, utilizing six personnel, requires the individual to enter the vessel wearing protective clothing and air line hose mask, remove as many elements as possible before skin burning occurs from fuel, and quickly exit, immediately showering and in most cases will be lost for the remainder of the day due to skin irritation.

The Navy needs a fuel filtration unit that doubles the flow rate to 4000 GPM, reduces the size and weight by half, and is maintainable at no health risk to the technician (i.e. eliminates the existing filter media). An additional challenge is the ability to operate while the ship is pitching and rolling. An industry survey has shown that there are no off-the-shelf solutions available, and advanced technologies will be required.

PHASE I: Provide a concept for fuel filtration that will meet the needs stated above. Assess the concept's technical issues and offer alternatives that address those issues. Prove that the concept is technically feasible either by analysis or lab demonstration at the company's facilities. Develop a work plan and proposal for Phase II.

PHASE II: Build a prototype filtration system that meets the stated needs and test the prototype at a landbased location to be determined by the government. Candidate landbased testbeds include simulated fuel systems at the Naval Air Training Facility, Pensacola, Florida, the Naval Air Systems Command, Patuxent River, Maryland, or the vendor's site. Develop a work plan and proposal for Phase III, including an estimate of cost.

PHASE III: Build a shipboard worthy prototype filtration system or modify the Phase II prototype. Demonstrate the unit aboard a carrier during technical evaluation (Techeval) and an operational evaluation (Opeval). Develop logistics support plan and user/maintenance manuals. Build production units.

COMMERCIAL POTENTIAL: The technologies developed under this SBIR project would have numerous applications in areas where filtration of solids from liquids is required. Examples include filtration of chemicals, oil, fuel, drinking water, and sewage treatment.

REFERENCES: Both references will be available through the DTIC internet site.

1. NSTM Chapter 542,(GASOLINE AND JP-5 FUEL SYSTEMS), S9086-SP-STM-010/CH, Chapter 6, PAGE 2, PARA 542-6.2. This provides a description for the current Filter/Separator for MOGAS and JP-5 Systems. It should be noted that proposals should not necessarily be limited to the technology employed by the current filtering system, and that innovative approaches are encouraged.
2. NAVAIR Aircraft Refueling NATOPS Manual, NAVAIR 00-80T-109. This provides an overview of carrier refueling practices and establishes the requirements for aircraft quality fuel.

KEYWORDS: Aviation Fuels, Filtration

N00-040 TITLE: Fire Resistant, Labor Saving, Reduced Weight, Pipe Coupling (Flange)

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop an alternative flange-like coupling for Naval and commercial service that reduces installation time[through reduction in bolts and designed-in bolt access improvement (possibly radial)], increases system survivability through enhanced fire-resistance, and is cost, weight and size comparable to existing ANSI and Navy flanges. Couplings shall be producable in materials used in Navy piping (copper-nickel, carbon steel and stainless steel), at a minimum. Modification of suitable COTS couplings, presently too costly and heavy, may be considered.

DESCRIPTION: Conventional flanges (both commercial and Navy) typically have many bolts which are axially installed around the entire circumference of the flange. This process requires equal access to all the bolts to ensure evenly torqued joints. It, therefore, frequently requires labor- intensive interference removal or results in inadequately tightened joints, leading to leakage. Conventional flanges also include gaskets which will leak in a fire scenario, due to bolt relaxation (creep).

PHASE I: Design and develop a cost-effective prototype suitable for the Naval environment. Develop a test plan to fully qualify the design for Navy environments (e.g., shock, fire).

PHASE II: Manufacture prototypes to the Phase I design and test IAW the test plan and make iterative design modifications, as warranted, until tests are completed successfully or restricted Navy applications are decided upon based on any test failures.

PHASE III: Implement the design into the fleet via commercial and Navy documentation issuance and update, and pursuit of ILS measures (e.g., training, supply support, COSAL and APL development etc.). Perform OPEVAL, as necessary, to demonstrate the couplings benefits, promulgating expeditious acceptance by the fleet.

COMMERCIAL POTENTIAL: Commercial designs having the desired features are too heavy and costly for Navy use, and are apparently only available in carbon steel. If smaller, lighter, more cost-effective couplings in a variety of materials are developed, the potential for commercial use would obviously supercede that of any similar existing designs, which are presently used in power plants, refineries and other shoreside facilities.

REFERENCES:

1. NASA Grayloc High-Pressure Couplings Test Report; TR-167-D, dated April 13, 1965
2. Grayloc Product Catalog
3. Newport News Shipbuilding and Drydock Co. Qualification Test Report on Model 4GR31, dated 12/4/98

KEYWORDS: Coupling; Fire-resistance; bolts; interference

N00-041 TITLE: <u>REMOTELY/EXTERNALLY ADJUSTABLE VALVE ACTUATORS</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles, Materials/Processes, Sensors/Electronics/Battlespace

OBJECTIVE: Develop modifications for COTS valve actuators to support Navy shipboard application. COTS actuators use remote (hand-held or hard-wired) controls to monitor actuator torque and limit switch conditions and adjust the same without invasive, and possibly contaminating, disassembly of the control module. Annual Preventive Maintenance Schedule (PMS) "open and inspect" requirements can be significantly extended, and associated PMS-induced casualties, resulting from improper re-assembly, avoided. Significant reduction in crew labor burden, and valve and actuator maintenance costs, is expected through the installation of modified COTS valve actuators which utilize external/remote controls (eg: infrared/push-button activators and LCD display screens).

DESCRIPTION: Electric valve actuators typically require adjustment of limit and torque switches to ensure proper operation, or as part of the ships' Preventive Maintenance System (PMS). This PMS is frequently unnecessary. Adjustment consists of disassembly of cover plates, exposing electrical and mechanical components to the elements, and proper adjustment of switches by hand. This procedure leads to casualties (e.g., improper re-assembly with resultant contamination and corrosion, and subsequent improper operation). At the very least, unnecessary PMS labor burden on the crew is promulgated. Valve material condition and performance can also be impacted by improperly set torque and limit switches. Inherent in this effort is a microprocessor control capability (including newly developed software) which allow real-time and cummulative performace diagnostic profiles of the valve to help determine when the valve/actuator needs maintenance; allowing for high confidence levels in PMS extension periods mentioned above.

PHASE I: Develop engineering data supporting modification of available COTS actuators, and determine which would be most cost-effectively modified for Navy environments and operating requirements (including, but not necessarily limited to, assessment of Navy unique aspects of corrosion, fire, shock, vibration, cycling and dynamic loading, ICAS compatibility, and envelope dimension requirements). Develop an ROM estimate on the cost to reach production levels and whether industry interest and base exists for same.

PHASE II: Develop prototype(s), incorporating design modifications as needed, and procure for testing. Test prototypes, as required (some manufacturer's tests may be satisfactory for extension to Navy applications), to qualify for the most severe Navy applications envisioned for this equipment.

PHASE III: Satisfy ILS needs of documentation, supply support, and repair and operational training. Submit informational rights to the Navy for future procurements, if negotiable. Perform TECHEVAL/OPEVAL as required.

COMMERCIAL POTENTIAL: Modification of existing COTS equipment will probably reveal little additional commercial potential except for applications in industry which are similar to Navy environments and requirements. Smaller units (required for Navy manifolds), for example, may widen the commercial market to manifolds and/or restricted spaces in power plants, commercial shipping etc.. Fire hardening may serve similar purposes for more severe/critical applications in industry vis-à-vis fire resistance and post-fire performance.

REFERENCES: MR&S/Sigmatech, "Autonomics for Reduced Engineering Maintenance; Final Report", 28 February 1997, pg. 23

KEYWORDS: Electric Valve Actuator, Condition Based Maintenance, Remotely adjustable, condition based maintenance, diagnostics

N00-042 TITLE: Cabling Jackets with Zero Halogen to Meet UL910 Flame Test

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop a jacketing material for shipboard fiber optic cable to meet commercial plenum cable flammability standards

DESCRIPTION: Currently available shipboard cables rely on flame retardant additives to meet minimum Navy requirements. However the additives, hydrated metal oxides, are different than those used in the commercial sector because of the Navy's requirement for zero halogen content. Also, formulations with hydrated metal oxides do not meet the commercial plenum requirements. It would be desirable to have zero halogen additives that meet the commercial plenum requirements per UL 910 in order to have a common base with the commercial sector. Then the Navy could more easily draw on commercial products to meet its shipboard cabling requirements. Also, since the effectiveness of the hydrated metal oxide additives diminishes in a prolonged fire condition, formulations that maintain their effectiveness under more prolonged exposure to fire would also be highly desired.

PHASE I: Identify formulations that may meet the Navy's shipboard cable requirements, have less than 0.2 percent halogen content and meet the UL 910 plenum requirements. If possible, perform laboratory tests. Perform production process and cost studies.

PHASE II: Select formulations from Phase I and produce samples to determine the ability to meet the UL 910 requirements as well as the Navy cable requirements. Determine ability of candidate formulations to be used in production cable processes, evaluate process variables and provide samples to the Government for evaluation.

PHASE III: Transition a formulation from Phase II into production for use by a Navy shipbuilding program and commercial users.

COMMERCIAL POTENTIAL: This product will be used in both Navy and commercial cabling. In addition, the differences between Navy shipboard cable and commercial cable will diminish so the Navy will have greater access to the commercial cable products.

REFERENCES:
1 Standard for Test for Cable Flame-Propagation and Smoke-Density Values, UL 910, Underwriters Laboratory, Inc.
2 Cables, Fiber Optics (Metric), General Specification For, Military Specification MIL-C-85045

KEYWORDS: cable; fire retardants; flammability, shipboard cable, plenum cable, cable manufacturing

N00-043 TITLE: Enhanced Resistance to Mine Detonation

TECHNOLOGY AREAS: Weapons

OBJECTIVE: To develop technologies that may lead to enhanced resistance to mine detonation.

DESCRIPTION: Preliminary NUWC studies have shown indications that bubble screens of the type produced by ship's "maskers" (which produce a bubble field around the hull) may lead to enhanced resistance to mine detonation due to the cushioning effect. It also may be advantageous to actively cancel the "whipping" (excitation of ship's bending vibration modes) resulting from a mine detonation (see references below). This topic involves both realistic modeling as well as scale tests to determine and optimize the parameters that would be needed for a realistic system.

PHASE I: Numerical modeling of conceptual systems. Determine approximate range of desired parameters.
PHASE II: Complete numerical modeling. Conduct scale tests. Design preliminary systems for use in Navy ships.
PHASE III: Finalize and transition designs for specific Navy ships.

COMMERCIAL POTENTIAL: Initially, the primary market is expected to be Navy ships. After the technology is proven and made practical, noncombatants would represent a significant secondary market. Specifically, oil tankers that must go into shallow water regions containing mines could be equipped to preclude an oil spill that would represent a major environmental disaster.

KEYWORDS: bubble; screen; masker; whipping; mine; cancellation

REFERENCES
1. Hicks, A.N. "The Whipping Forces Experienced by a Ship Very Close to an Underwater Explosion," Naval Ship Research and Development Center Report 3271.
2. Jones, J.P. and Ortloff, C.R. "Blast Wave Hardening of Underwater Structures with Bubbly Water Layers," Air Force Report No. SSD-TR-66-199.
3. Strange, J. and Miller L. "Shock-Wave Attenuation Properties of a Bubble Screen," Army Engineer Waterways Experiment Station, Tech Report 2-564.

N00-044 TITLE: A Dynamic Configurable MCM Assessment Tool for Amphibious Assault Operations

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Mine Warfare

OBJECTIVE: Develop a computational method and prototype tool to determine the casualty-production capability of an anti-amphibious assault minefield from partial knowledge of its composition. This tool must also be able to determine the impact of the minefield's casualty-production capability on the forces safely delivered ashore subsequent to the operation of specified MCM efforts.

DESCRIPTION: Designing and assessing the effectiveness of mine countermeasure (MCM) operations is important in minimizing effects of anti-amphibious assault minefields. A computational tool that is useful in assessing the effectiveness of MCM operations in such minefields must correctly quantify the effects on casualty production and timely projection of forces ashore of a specified level of MCM effort (i.e., specified number of minesweepers in operation for a specified amount of time). More particularly, the tool should enable the user to examine the relationships among (i) the risk of delivering insufficient forces safely ashore within a specified time, (ii) the number and characteristics of boat lanes, (iii) the minesweeping resources committed, (iv) the time allocated for minesweeping, and (v) the threat mine stockpile. The user can thereby assess the resources and time needed to ensure an acceptably high probability of delivering the required forces ashore in at most the maximum allowable time.

The computational tool must accommodate the operational characteristics of threat mines, including such features as sensitivity and ship-counter settings. It should provide, in a manner suitable for the assessment of minesweeping operations, a foundation for its extension into a tactical decision aid that incorporates intelligence, surveillance, and reconnaissance information as it becomes available. It must also be suitable for execution on a high-end desktop computer.

Operational uncertainties accompany any mission involving transport of vehicles through a mined-area (e.g., operational uncertainty of behavior of mines, ships, countermeasures vehicles considered separately, plus the higher level uncertainties involved in the mine-ship and mine-countermeasures vehicle interactions that will occur throughout the mission). Successful performance of this computational tool will be measured in terms of the accuracy of stated probabilities, probability distributions and their moments -more specifically in terms of operationally useful bounds on such moments.

The idea of creating a PC-based tool to assess the effect on an amphibious assault operation of a minefield wherein only partial knowledge of the composition of that minefield is known is highly innovative, and therefore involves considerable technological risk. It will require both innovation and creativity in order to create the tool having the capabilities described herein on even a high-performance desktop computer.

PHASE I: Develop the architecture of the computational tool. Provide a report that includes a discussion of the mathematical methodology, together with illustrations showing how this methodology is utilized and how it could be extended to situations in which intelligence, surveillance, and reconnaissance information become increasingly refined. Provide a description, in the form of structural block diagrams, which specifies the architecture of the tool, including its principal components and how they interact. Define measures of effectiveness/performance by which the prototypal tool can be evaluated.

PHASE II: Develop a prototype tool that, at a minimum, implements the architecture specified in Phase I in the form of a computer program that executes on a high-end desktop PC. An alpha-test module, which may be limited in functionality but must be capable at least of performing the computations used as illustrations in the Phase I report, is to be provided one year after Phase II commences. The computational tool is to be described in a technical report. The description of its logic and mathematics is to include a discussion of the variables and parameters that are used, the derivations of the mathematical relationships among them, and a description of the computational procedures and corresponding algorithms. The use of the tool is to be explained in a draft user's manual. Also to be included is source code (ASCII files) and annotated source listings of all the modules; a symbol dictionary that defines all input variables, output variables, and program constants; and block diagrams and flow charts of the algorithms and procedures. Accompanying the source code is to be an executable file together with a set of test cases sufficient to verify the algorithms and procedures. The documentation should also include a verifiable assessment of the Phase II tool in terms of the measures of effectiveness/performance that were defined in Phase I.

PHASE III: This Phase will extend the mathematical structure of the Phase II product to incorporate intelligence, surveillance and reconnaissance (ISR) information in near real-time. The end product will be a computational tool for assessing risk in the course of an amphibious assault operation and for controlling the MCM and penetration tactics in order to minimize mission risk. This tool will be able to be incorporated into a Tactical Decision Aid (TDA) for planning, controlling and assessing amphibious assault and associated MCM operations that would be used by Commander Mine Warfare Command (COMINEWARCOM) as an MCM planning tool. This TDA would also be likely to transition into the US Navy's Mine Warfare Environmental and Decision Aids Library (MEDAL). The real-time TDA would be used by both Amphibious Task Group and MCM Commanders for planned and on-going amphibious operations and their supporting in-stride mine clearance/neutralization efforts as a part of Organic MCM.

COMMERCIAL POTENTIAL: There are numerous other applications involving complex interacting entities (man, man-made systems, markets, etc.) wherein the objective is to assess risk, potential profit, etc. The sophisticated use of non-classical optimization methods required for solving the problem at hand could be of interest to problem solvers in these other domains.

KEYWORDS: Configurable Theory; Amphibious Assault; Mine Countermeasures; Computational Tools; Tactical Decision Aids; Organic MCM

N00-045 TITLE: Laser Radar (Lidar) Remote Wind Sensor for LCAC

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Mine Warfare

OBJECTIVE: To develop a sensor using laser radar (lidar) technology that is capable of accurately measuring downrange and cross-range wind speeds to 1 m/sec accuracy at ranges from 400 to 1000 ft and altitudes from 30 to 150 ft. The system must have the capability of providing raw and/or averaged data in real time to a fire control system. The system must be capable of installation on the Navy's Landing Craft, Air Cushion (LCAC) and as such, must be capable of operating in the full range of craft environments: motions, sea spray, bow thruster exit airflow, craft-induced vibration, and hot and cold temperature extremes. The system must be able to be mounted on the LCAC superstructure without physically or operationally interfering with the existing craft systems. The estimated production cost of the final deployment system must be below $150K each and the system must be eye-safe.

DESCRIPTION: The inability to measure wind conditions is the largest error associated with launching assault breaching systems from LCACs. Currently the LCAC has no onboard sensor to measure wind speed and direction either near the craft or between the craft and the beach. Installations of mechanical and acoustic anemometers were unsuccessful because of the airflow produced by the craft's bow thrusters, lift fans, and propellers, and seawater spray escaping the skirt. The most promising system tested on the craft was a lidar; however, it was a relatively large, land-based system mounted on the craft for one test only. A compact, eye-safe system is needed that can be installed without affecting craft performance or load carrying capacity. Since lidar systems have been demonstrated to meet the accuracy/range/altitude, eye-safe and real-time data requirements, the primary risk is to develop a compact system compatible with the full range of LCAC environments within the target production cost. Success will be judged by comparing data from a land-based anemometer in the designated target zone approximately 1000 ft away with data from the candidate system operating from an LCAC hovering on cushion just outside the surf zone, with bow thrusters fully operational. Because of the high costs associated with testing the full range of craft environments, verification of performance in the extreme temperature and vibration environments will be done in land-based laboratories. Satisfaction of the cost requirement will be through a detailed cost estimate of the production system to be provided by the Contractor.

PHASE I: Review the state-of-the-art wind sensors for their applicability to the operational environment of the LCAC and the requirements herein. Design and develop a compact, safe prototype system compatible with the LCAC and meeting the operational requirements. A detailed cost estimate for the production system will also be developed during this phase.

PHASE II: Based on the Phase I design, fabricate and test a prototype. All Phase II testing will be land-based. Testing will be conducted first in the laboratory, then in a static installation and next on a motion platform capable of simulating LCAC motions. The systems will be evaluated on its the capability to measure downrange and crosswinds at distances between 400 and 1000 ft downrange.

PHASE III: Test the system installed aboard an LCAC. With the LCAC operating in a representative ABS environment, i.e., on-cushion and stationary, evaluate the system on its the capability to measure downrange and crosswinds at distances between the craft and the beach of 400 and 1000 ft. Following successful completion of the at-sea testing, develop production drawings and documentation that would enable the Navy to procure up to 36 production systems. It is expected that installation of the production systems would be implemented as part of a craft alteration.

COMMERCIAL POTENTIAL: There is considerable potential use for a rugged, compact wind sensor in the private-sector. Not only could the system be used to measure wind conditions from aircraft, sailboats and other vehicles for which wind data is necessary, but it could also be used in remote sites to measure wind conditions at airports and in support of tornado warning systems.

REFERENCES: "Coherent Lidar Wind Profiling Demonstration and LCAC Exit Air Velocity Survey, Final Report," Coherent Technologies, Inc., Report CTI-TR-9804, February 1998.

KEYWORDS: wind measurement; lidar; laser radar; in-stride breaching; mine neutralization; organic MCM

N00-046 TITLE: Non-Contact Measurement of Ocean Currents

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Mine Warfare

OBJECTIVE: Develop the methodology and equipment needed to measure in-water currents remotely from a helicopter.

DESCRIPTION: The methodology and equipment to be developed will be capable of measuring sub-surface bulk water currents to an accuracy of one knot in speed and within five degrees in direction, while correcting for surface motion due to wave action. Determining the current structure as a function of depth is also desired. The measurements must be capable of detecting a one-knot current, if present. It is anticipated that the technique will be optical in nature, but other techniques and approaches will be considered. It is intended in the Navy application to operate the developed system from a helicopter in low-altitude operation (below 500 feet), so the equipment developed needs to incorporate shock and vibration mitigation.

Although laser speed-measurement devices exist (such as police laser radars), the measurement of ocean currents is a more difficult proposition, in part due to the necessity of making sensitive measurements (to within one knot in currents which may be in the one knot range) in the presence of surface wave phenomena which provide a noise source to the desired measurement. It is necessary for the contractor to establish a measurement methodology that allows for making this correction, as well as developing the equipment necessary for making the measurements.

PHASE I: Design and develop a remote metrology system for sensing in-water currents, identifying the models, analysis, and experiments and simulation as appropriate and necessary to determine the equipment required to make the desired measurements, and establish the theoretical basis needed to analyze the resultant data. It will be the responsibility of the contractor to determine the developmental methodology and techniques to be used in this Phase, but the Navy may provide background information concerning the specific mission, expected operating platform, and such other operational information as may be required.

PHASE II: The contractor shall fabricate a prototype system based on the design of Phase I including the equipment needed to conduct a demonstration of the remote water-current measurement capability. The demonstration process may occur in two stages: the first stage demo may be executed from a fixed site, with the second stage from a Navy-supplied helicopter (or, at the Navy's discretion, from an equivalent platform). The equipment is expected to be at least at a breadboard state of development, with only such additional engineering for mission suitability as is necessary to permit routine operation from a helicopter by Navy personnel.

PHASE III: This Phase will be executed under the auspices of PEO(MIW)/PMS-210 to transition the Phase II-developed capability into a militarily-useful product. The contractor shall produce production-level drawings and documentation that would enable the Navy to procure production-quality helicopter-deployable systems.

COMMERCIAL POTENTIAL: There are numerous potential uses of such a system capable of remotely measuring ocean currents, including such diverse areas as fishery management (fish habitat location), civil engineering (at the site of proposed bridges and piers), and environmental (determining probable transport paths for pollutants). Such uses are not individually thought to provide a sufficient need that they are likely to result in the development of this capability, but are a practical market for such a capability once developed.

REFERENCES:
1. Stachnik, William "The Laser Scanning Vorticity Meter ¼", SPIE v. 208 Ocean Optics 6, p. 214 (1979)
2. Stachnik, W.J. and W. T. Mayo, Jr., "Optical Velocimeters for Use in Seawater", Oceans '77 (IEEE 77CH1272-4 OEC) V.1 p. 18A (1977)

KEYWORDS: Optical velocimetry; current measurement; physical oceanography; remote sensing; mine countermeasures; organic MCM

N00-047 TITLE: <u>LASER Vibration Monitoring of Unmanned Machinery</u>

TECHNOLOGY AREAS: Materials/Processes, Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO for Submarines

OBJECTIVE: Develop machinery condition monitoring for unmanned spaces using LASER-based vibration in a comprehensive autonomic condition monitoring system.

DESCRIPTION: LASER measurement of machinery vibration levels offers potential to permit autonomic monitoring machinery health in unmanned spaces. Changes in vibration levels tracked over time may indicate impending corrective maintenance requirements or performance degradation. Large expensive equipment such as gas turbine engines already are equipped with hardwired accelerometers (mounted on the equipment) which utilize alarm and trip set points. However, the cost and upkeep of accelerometers and their associated controls is usually not warranted on less expensive equipment such as pumps, refrigeration units, etc. These equipments are grouped in Auxiliary Machinery spaces and presently are monitored by personnel. A centrally mounted LASER vibration measurement device is desired to remotely scan and monitor all the machinery in the space. The central LASER is the only component to be hardwired into a ship computer node. The technical challenge is (1) to verify that lasers can accurately measure machinery vibration, (2) to design a single source laser that is central to a space which can measure multiple machinery sources, (3) establish a baseline, trend the data and recognize anomalies.

The risk is that sufficient accuracy is not obtainable or that this technology can be demonstrated in a laboratory and not be capable of being ruggedized to withstand the rigors of fleet use.

PHASE I - Design and develop a centrally mounted, non-contacting LASER vibration measuring system that can contribute to a complete autonomic Machinery
Condition Monitoring System. Demonstrate the ability of LASER instrumentation to scan and measure vibration signatures with results comparable to an accelerometer.

The LASER vibration monitor performance must be comparable to standard hardwired accelerometers. The range of vibration must cover from zero to 15 mils (.001 inch) displacement, measurable in narrow band and broad band frequencies up to 262Khz. Vibration characteristics in both velocity and acceleration over the same ranges should be obtainable. The comparability results must agree over the entire speed range within one half mil. Reliability of the laser must be predicted to meet 20,000 hours of shipboard operation without drift exceeding .25 mil.

PHASE II - Construct and demonstrate a breadboard LASER vibration monitoring system suitable for use in Auxiliary Machinery spaces.

PHASE III - Construct and demonstrate a commercial grade LASER vibration monitoring system, suitable for shipboard demonstration and integration into a shipboard control system. Demonstrate operation of the system in controlled and at sea conditions.

COMMERCIAL POTENTIAL: Private sector applications are the same as Navy, specifically remote monitoring of machinery health. Manpower reduction requirements for cost control are pushing industry for solutions to machinery monitoring. The importance to industry is the same as the Navy. Remote (no-contact) solutions to vibration measurement will save on installation costs and integrate into a complete Machinery Condition Monitoring System.

KEYWORDS: LASER; Vibration Monitoring; Machinery Condition Monitoring.

N00-048 TITLE: Design and develop a real-time on-line RMA trends and analysis reporting assessment database for Towed Array Systems

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO for Submarines

OBJECTIVE: Develop a centralized repository for towed systems RMA data and integrate it with modeling and simulation tools to predict the health of systems analyzed.

DESCRIPTION: The availability of a submarine towed array data acquisition system can provide real time data into a database maintained at a central site. By making the central repository accessible through an internet site all data collected is automatically entered into a common database with access from data suppliers and users. The data collected into this common database is then accessible to an automated trends and analysis software suite of Reliability and Maintainability tools. As the data is collected by the database it is processed through this set of tools. Class wide results can be provided as frequently as the data is uploaded to the database; i.e. each time a ship or maintenance facility enters data. The users would be able to see reports updated in real time by visiting the web site. Current RMA cataloguing systems do not have the ability to do any real-time trend analysis and are incapable of forming a predictive model.

The use of statistics and decision analysis tools could be used to provide predictability of future system operational performance and be adaptable to real time data. Thus, an improvement in system design or operation that is expected to change reliability can be monitored for its contribution as soon as data from the ship with the improvement is entered into the system. Responsiveness of the overall towed system can be gained in shortening the design, install, operate and evaluate cycle. Additionally, users of submarine towed systems would have access to the data, see the results and have common reference for which improvements are necessary and where improvements provide the most return for the invested cost.

PHASE I: During Phase I, the contractor would design a real-time on-line RMA trends and analysis database. This design would include determining what types of information would be required from the field. The design will also include the piece of the system that will be used by field personnel to collect and access the data. They will also design the algorithms that will be used to predict reliability trends from data that was entered into the system. There should also be investigations into ways that data could be collected automatically from submarines and towed systems.

PHASE II: Build one full system, including the central database, analysis tools, and at least one of each type of data collection station.

PHASE III: Build sufficient systems for fleet use.

COMMERCIAL POTENTIAL: This system could be adapted for numerous other uses throughout the military and commercial sector, such as maintenance of transit systems, manufacturing machinery, tanks, whole ship monitoring systems, etc.

KEYWORDS: Reliability; availability; maintainability; monitoring; automatic; database

N00-049 TITLE: Innovative Signal Processing Concepts for Active Emissions

TECHNOLOGY AREAS: Information Systems, Sensors/Electronics/Battlespace, Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO for Submarines

OBJECTIVE: Develop innovative signal processing techniques which can fully exploit the full detection and localization potential of sensor suites installed as part of today's combat systems. Specifically, improvements to the detection and localization of active emissions (eg. incoming torpedoes) is needed to provide a defensive capability which rapidly and clearly identifies and localizes threats. Automation of the detection, classification, and localization process is desired.

DESCRIPTION: Detection and localization processing provided by today's stand alone active emission signal processors are the limiting factor in providing needed capability, relative to the overall system potential of the acoustic sensors. Current combat system sensors can provide the ability to more rapidly detect and localize active emissions than current processing provides. Development of innovative concepts that maximize the use of various sonar sensors, automate localization and classification functions, and provide advanced visual techniques to enable rapid decision making substantially increase survivability.

PHASE I: Develop innovative signal processing concepts for the detection and localization of active emissions based on the current sensor suites of available combat systems. Identify requisite technology developments including but not limited to sensors, processing, and data presentation.

PHASE II: Design and fabricate a "brass board" prototype based on the design developed in Phase I and perform a proof of concept demonstration.

PHASE III: Develop a prototype model for qualification, test and evaluation and production purposes, including supporting software and documentation, for an active emission detection, tack, and localization subsystem that can be integrated into an existing submarine and surface ship combat system.

COMMERCIAL POTENTIAL: These approaches to innovative signal processing concepts can be transferred to other areas of the commercial world in which detection decisions are required based on the detection and localization of acoustic information. Some other applications include air traffic control systems; military ground based and airborne systems; and automated vehicular traffic control systems

KEYWORDS: Active Emission; Signal Processing; Acoustics; Multi-Sensor Exploitation; Tactical Information Processing; Display Visualization

N00-050 TITLE: Smart Tools to Support Shipboard Network Administrators

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO for Submarines

OBJECTIVE: Develop software tools to assist shipboard network administrators.

DESCRIPTION: Navy ships and submarines are becoming heavily network centric, yet the maintenance and administration of the computer networks aboard ship has, to date, been considered a 'collateral' duty. There is presently no career path for network administrators, nor is there a training curriculum to ensure that the computer networks aboard ship will be adequately maintained. There is a need for a set of software tools that can quickly provide network administrators with necessary troubleshooting and status data in a simple, easy-to-use manner.

Such a toolset would benefit network administrators by allowing them to easily ascertain the present health of the network and quickly identify network resources that may require attention. In this context, "network resources" includes both hardware (workstations, servers, routers, hubs, switches, and other devices physically connected to the shipboard network) and software (system and user applications running primarily on UNIX and Windows NT-based platforms.) It is expected that the toolset will provide administrators with a means of examining and maintaining the configuration of network resources, provide a basic test capability to ensure proper functioning of a given resource, and offer a means of alerting an administrator when a failure has occurred.

The submarine environment poses several unique challenges to the development of a network administration toolset. The tools must support a wide-range of hardware not found in most commercial network environments, must interface with custom-built Navy applications and software products, and must function in a non-invasive manner to protect the integrity of tactical applications and hardware. Such requirements have precluded the use of existing commercially available tools and will likely require the development of new approaches and tools for use in the submarine environment.

PHASE I: Establish the technical requirements for a software toolset to support network system administrators aboard Navy ships and submarines. Develop a top-level design Graphic User Interface for the toolset.

PHASE II: Complete a detailed design for the toolset. Implement the software in code and produce a prototype.

PHASE III: Demonstrate the toolsets capabilities to support system administrators on a specific Navy vessel (e.g., USS Virginia, SSN774) and extend the system to encompass other classes of Navy ships/submarines.

COMMERCIAL POTENTIAL: The use of standard networking protocols and technologies as a means to upgrade aging and/or proprietary systems and networks is becoming more and more common in the commercial marketplace. However, many of these systems and networks will continue exist in the same highly specialized environments that necessitated their original proprietary design. This will create significant commercial potential for a network toolset that can be readily adapted to support custom applications and environments.

KEYWORDS: computer networks; system administration

N00-051 TITLE: Development a Nondestructive Evaluation (NDE) Technology for Inspecting Structural Welds under Coatings

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO for Submarines

OBJECTIVE: Develop an NDE technology to inspect, for planar and volumetric flaws, full-penetration butt welds covered by a protective and energy dissipating synthetic coating. Inspection technology must allow for all inspection work to be done from one side (through the coating), and should have potential for field deployment.

DESCRIPTION: Routine NDE inspections of hull welds in Navy ships and submarines support the lifetime monitoring each ship's structural integrity. The location and sizing of planar and volumetric defects factor into the determination of maintenance and repair plans. The recent introduction and increasing use of advanced coating systems - some with significant thickness and energy dissipating properties - presents a challenge to conducting these NDE inspections with current methods and technologies unless the coating is first removed. (This removal and subsequent reapplication process creates additional work that is undesirable.) All NDE technologies are based on physics. All technologies used by the Navy for inspecting structure are based on the ability to input an energy signal, have it interact with a defect, and obtain an output signal that can then be interpreted. The advanced coating systems, by their very nature, serve to defeat the capability to even input a conventional NDE signal. Despite attempts, no NDE technique has demonstrated the ability to pass a signal through the coating, interrogate the underlying metal structure for defects, and return a signal to the outside of the coating. Current inspection methods permit the use of either ultrasonic or radiographic technologies, although the ultrasonic technology has become the more desirable of the two since it has many advantages over conventional radiography (Ref 1). The capability to conduct inspections completely from the outboard side of the hull is a major advantage of the ultrasonic technology and will continue to be a desired characteristic of new technologies for inspecting through the hull coating. Success will be recognized when the contractor demonstrates the ability to detect, locate, and size a discontinuity from the coated side of a test panel. The discontinuity will be embedded approximately 1/2t (t= thickness of the metal) through the metal and have a maximum dimension of 1/8 inch.

PHASE I: Develop a candidate technology and demonstrate its feasibility for conducting inspections of Navy hull welds through various advanced Navy coatings. (The contractor must obtain clearance for working with classified information.)

PHASE II: Develop the technology and design/build a prototype inspection system for full-scale field trial use and in accordance with current Navy inspection capability criteria.

PHASE III: Develop a field-deployable inspection system for Navy and shipyard use.

COMMERCIAL POTENTIAL: Structural weld surveillance varies in complexity from industry to industry. Several industries make extensive use of rubber/rubber-like coatings, but the applications (primarily tank and other fluid system linings) tend to not interfere with the conduct of weld inspections.

REFERENCES: DeNale and Lebowitz, "Ultrasonics as an Alternative to Radiography for Submarine Hull Weld Inspection," DTRC_SME_90/30, February 1990. (limited distribution)

KEYWORDS: nondestructive inspection; welds; coatings; flaw sizing.

N00-052 TITLE: Application of Virtual Large Display Video Goggles to Submarine Imaging Systems

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO for Submarines

OBJECTIVE: Develop the capability to utilize Virtual Large Display Video Goggles as a peripheral display device in real time submarine video imaging systems.

DESCRIPTION: Current submarine imaging systems require large (19+ inch) video display units (either CRT or flat panel) viewed at close range in order to adequately see incoming external video. This ties the operator of the imaging system to the display console. Divorcing the operator from the display console frees him/her to interact with other operators and watch standers while viewing external video. In recent years, commercial vendors have developed virtual large display video goggles providing the equivalent display surface of an 80" television screen for personal computer games. Adaptation of one of these goggle technologies for submarine imaging systems not only frees the operator from the display console, it also provides the added benefit of elimination of high power consuming CRTs. Additionally, head-tracking capability will be considered for control of the video imaging sensor line of sight.

PHASE I: Design and develop the application and use of video goggles as a display device for submarine imaging systems. The Phase I effort should include a laboratory demonstration of realtime video imagery over video goggles, and features critical to use aboard submarines.

PHASE II: Fabricate a prototype video goggle display and associated software based on the Phase I design. Demonstrate the prototype display on a submarine imaging system. Any software required for interface must run on a Sun Sparc processor.

PHASE III: Integrate the Phase II prototype display into existing U.S. Navy submarine imaging systems. Full CSCI documentation shall be provided along with the software in accordance with standard Navy guidance.

COMMERCIAL POTENTIAL: The commercial applications for this technology include government military applications and commercial video applications. Navy surface ships and aircraft employ video display for tactical and strategic missions which could benefit from this technology. In addition, commercial high end video acquisition, processing, and editing systems used in the advertising, entertainment, and medical fields will take advantage of this research.

REFERENCES:
AN/BVS-1 video distribution drawings
AN/BVS-1 Internal Electronic Unit Critical Item Design Specification.

KEYWORDS: video, photonics, goggles, submarine, imaging, display

N00-053 TITLE: Highly Directional Compact UHF Antenna

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO for Submarines

OBJECTIVE: The objective of this topic is to develop approaches to providing a compact highly directional antenna with low side-lobes to reduce vulnerability of UHF communications to intercept/geo-location.

DESCRIPTION: Radio communications is becoming increasingly important in naval operations. A significant amount of the terrestrial communications will occur in the UHF band. In order to reduce interference and reduce vulnerability to intercept, geo-location and jamming, highly directional antennas are required. Typically, highly directional antennas at UHF frequencies, tend to be large in size which restricts their installation to either ground or large platforms. Directionality, combined with the space constraints on smaller air or surface platforms, involve technical challenges to be overcome. The objective is to provide the maximum directionality and minimum side and back lobes in the horizontal plane.

PHASE I: Develop a design for a directional UHF antenna designed to fit inside the volume enclosed in a right circular cylinder 18 inches in diameter and 35 inches high. The target frequency range for operation is 800 MHz to 2500 MHz. The contractor shall provide a detailed analysis of the expected performance of the proposed design. An appropriately scaled model of the proposed antenna shall be constructed and its performance measured. The measured performance shall be compared to the predicted performance.

PHASE II: The contractor shall construct A full scale model of the antenna design developed in Phase I of the SBIR. The performance of the antenna will be measured and compared to the predictions and measured results of Phase I.

PHASE III: A successful antenna design would lead to construction of a prototype antenna for installation on a submarine. The contractor would participate in the construction of the antenna and integration of the antenna to operate in the submarine application.

COMMERCIAL POTENTIAL: A successful antenna design exhibiting a high degree of directionality in this frequency range has potential application in the cell phone and PCS industries.

KEYWORDS: submarine antenna; directional antenna; low sidelobes

N00-054 TITLE: Non-Metallic Bearings

TECHNOLOGY AREAS: Ground/Sea Vehicles

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO for Submarines

OBJECTIVE: Identify, design, and test non-metallic bearings for Navy use.

DESCRIPTION: Develop non-metallic bearings for Navy applications. The Navy currently uses bearings that are required to operate in a variety of environments simultaneously including: dry; in a submerged marine environment; under significant physical loads; at great depths; and under ambient temperatures ranging from 30 to 125 degrees F. These bearings are used in many different types of rotating machinery, many with large diameter shafts and great loads (2 to 3 tons per shaft). There are several drawbacks to the bearings currently in use in these applications, however. They require lubrication, which must be maintained even at great depths. Inspecting and re-lubricating these bearings is very expensive. These bearings have also been known to crack under load. This effort would improve the existing implementations and allow for expanded application. Non-metallic bearings may have several advantages over metallic/roller type bearings. The challenge is to develop bearings that will meet the requirements of no lubrication, low friction, and high strength while maintaining low cost and the ability to operate in all environments mentioned above.

PHASE I: Select material and design bearings for a selected submarine application. The following criteria could be important factors in material selection: PV rating, loading capacity, seawater compatibility, water absorption characteristics, friction factor, and environmental regulation compliance. The bearings should be designed so that they require no lubrication when running in air, and are also compatible with running while submerged at great depths in seawater.

PHASE II: Produce prototype bearings for use on both land-based and at sea testing facilities.

PHASE III: Produce a quantity of bearings for Fleet use.

COMMERCIAL POTENTIAL: The industrial world has many uses for bearings for heavy rotating machinery. This includes the marine industry, heavy manufacturing, and the oil industry.

KEYWORDS: Non-Metallic; Bearing; PV Rating; Marine Environment; Breakaway Friction; Water Absorption

N00-055 TITLE: Digital Radar Receiver on a Chip

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: The objective is to develop a high performance digital receiver as a MMIC part or a large hybrid single chip part.

DESCRIPTION: In a "Digital Radar", digital T/R modules are physically located behind each radiating element in the radar antenna and only digital information is transferred over fiber optic links between the processor and the T/R Modules. Each digital T/R module converts a digital waveform to analog, frequency up-converts, amplifies and radiates it. After the radar echo arrives at the antenna, it is passes through a receiver protector, and the echo signal is down-converted in frequency, passed through an A/D converter, converted to base-band, and then transferred to the processor over the digital fiber optic link. A feature of a digital Radar is to provide an up/down conversion process at each radiating element. This process should have high performance, be on a single chip, and be fairly low cost. Current technology uses surface mount mixer, amplifier, and filter components to perform this function. There is significant flexibility in the development of the "Digital Radar Receiver on a Chip."

An example set of specifications are:

Operating frequency 3.1 to 3.5 G-Hz
First IF 915 MHz
Second IF 45 MHz
Bandwidth 10 MHz
1 dB compression at 915 MHz 95 dB at 45 MHz 80 dB
Phase noise floor -155 dBc/Hz
Size desirable MMIC chip
required large hybrid chip

PHASE I: Develop alternate design(s) for the 'Digital Receiver on a chip' suited to the digital T/R module application, select the design which achieves the best required performance from among the various alternative designs, and provide necessary design disclosure information. A successful design will constitute the first fully digital radar receiver and shall provide both small size and high performance simultaneously.

PHASE II: Fabricate prototype 'Digital Receiver on a chip' units which conform to the Phase I design within the size and cost constraint(s) and demonstrate their
performance. A successful prototype will meet the size and performance requirements described herein and develop any necessary new fabrication technology.

PHASE III: Integrate the Phase II prototype 'Digital Receiver on a chip' into digital T/R modules supporting the Navy Volume Search Radar (VSR) program, and into the Advanced Multifunction RF System (AMRFS).

COMMERCIAL POTENTIAL: These 'Digital Receiver on a chip' units could find wide and ready application in the rapidly growing wireless communication industry (cellular phone relay units). Other (lower volume) applications include Law Enforcement Radar, Weather Radar, and NASA Remote Sensing Radar all of which could employ these compact digital receivers to good advantage (lighter, smaller size, enhanced performance).

REFERENCES:
1. MMIC Devices
2. MEMs Devices

KEYWORDS: Receivers; Digital Receivers; MMIC; chip; radar; multifunction

N00-056 TITLE: <u>Low-Cost Net-Form Fabrication of Hot Gas Valve Components</u>

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: Develop and demonstrate low cost net or near-net form manufacturing processes to produce high temperature, oxidative resistant components for ducting and controlling hot gases with temperatures over 3500°F.

DESCRIPTION: The Navy and other DOD activities are currently developing Divert and Attitude Control Systems (DACS) to provide multi-axis propulsion control authority for endo- and exo-atmospheric interceptors (i.e., Area and Theater-Wide Defense). Evolving Navy divert propulsion systems utilize solid propellant DACS technologies, which have limited performance and are very costly to produce. Future Navy divert propulsion systems need to have a combination of a higher degree of energy management flexibility, higher performance, reasonable weight and a significantly reduced cost. This combination of performance and cost characteristics is extremely challenging and yet to all be achieved in a single application. Ducting, control and energy management of solid divert propulsion systems demands development and manufacture of complex, precision and durable hot gas valve components. Future components must survive exposure to oxidative hot gases of over 3500°F, under demanding structural conditions (e.g., dynamic gas flow, valve impacts, severe thermal gradients, etc.). Components must also survive with near zero erosion, to maintain critical flow passage geometry. Currently, specialty high temperature materials must be used to support design and construction of hot gas valve assemblies. Manufacturing of these specialty materials is complex, resulting in long fabrication cycles and in very high cost. A number of high temperature materials have thermal and oxidative resistant characteristics that suggest that they might be suitable to the intended application. However, many of these materials are difficult to form into complex shapes, are difficult to join, and are not impact resistant. Other materials have the appropriate properties and can be formed into complex shapes, but they are very costly to manufacture.

The intent of this SBIR topic is to develop and demonstrate advanced hot gas valve material and manufacturing technologies which yield near-net or net-shape configurations. Demonstrated components must be fabricated of materials and in configurations which can withstand the thermal, chemical, erosive, structural and geometric requirements of future DACS propulsion systems. Selection shall be biased towards technologies which demonstrate the following attributes: (1) Near zero erosion when exposed to hot propellant gases of >3500°F for up to 100 seconds, (2) the ability to fabricate viable near-net shaped hot gas components at low cost, and (3) the ability to fabricate viable hot gas valve assemblies with short fabrication cycle times and low part counts.

PHASE I: Produce samples representative of hot gas valve components using appropriate high temperature, oxidative resistant materials. Samples must be fabricated using near-net or net forming fabrication approaches and materials intended for transition to Phase 2. Devise and conduct thermal, structural and chemical resistance testing to demonstrate viability of transition to Phase 2. Preference will be given to contractors who conduct hot-fire testing of components. Identify cost reduction, fabrication cycle time, and reduced complexity improvements over state-of-the-art hot gas valve technologies.

PHASE II: Scale-up material and fabrication processes. Fabricate net-formed hot gas valve components and validate adequacy of these components through hot gas testing (>3500°F). Conduct complete thermal and structural characterization of the selected material and fabricated components. Identify property variation versus major processing parameters.

PHASE III: Transition technologies to the STANDARD Missile vendor base.

COMMERCIAL POTENTIAL: The proposed topic has application to the following products, representing notable commercial potential: other DOD solid divert hot gas valve assemblies (AIT, LRALT Trajectory Adjustment Module, and Trident Post Boost Control System), reduced smoke solid propellant rocket motor nozzles, liquid propulsion combustion chambers/nozzles, aero-thermal protection of high-speed flight vehicles, high temperature turbine engine components, and other high temperature applications.

REFERENCES:

1. Papers (1997 JANNAF) and discussions on Rhenium and Hafnium based high temperature materials with Dr. Mark Opeka of the Naval Surface Warfare Center, Carderock, MD.
2. Martin Minthorn, April 1999 MANTECH Issue Paper (No. 2171) titled "Rhenium Fabrication Processes"

KEYWORDS: Hot Gas Valves; Divert and Attitude Control System; high temperature materials; net-form fabrication; low cost manufacturing

N00-057 TITLE: Propulsion Improvement for Long Range Guns

TECHNOLOGY AREAS: Materials/Processes

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: Increase the muzzle velocity and thus the range of Navy guns, without significant alterations to current Navy gun configuration, and without exceeding maximum chamber pressure, muzzle exit pressure, and projectile acceleration limits.

DESCRIPTION: This topic seeks methods to improve a gun's propulsive efficiency by increasing the area under the projectile base pressure vs. time curve. In a gun, propulsion gases occupy an expanding volume, defined by the breech and moving projectile base, and are produced by combusting propellant. In most cases, the pressure at the projectile base is lower than at the breech. The Constant Breech Pressure (CBP) analysis, a reasonably accurate method for predicting the maximum achievable muzzle velocity for a gun, assumes a linear velocity gradient for the gas from the breech to the projectile base. The topic seeks approaches, tools, models, and processes to improve the physical interaction in the gun's barrel to alter the velocity and density profiles of the propellant gas behind the projectile, to increase the base pressure (while not increasing the breech pressure) to achieve the objective. This would result in velocities greater than that predicted in the Constant Breech Pressure analysis. One method assumed to achieve improved efficiency is the 'travelling charge', in which propellant, in the form of a fast-burning rocket grain, is attached to the projectile. This design, instead of generating gas uniformly through the expanding volume, generates gas at the projectile base, with a rearward velocity. Thus an innovative combustion configuration can modify the velocity and density profiles and may produce improved performance over that predicted by the CBP analysis. However, travelling charge proposals would need to address various issues associated with the travelling charge concept such as explosive safety concerns, higher muzzle exit pressures, high sensitivity of the propellant, and increased weight (see ref (2)). Other concepts may include, but is not limited to, layered propellants, a travelling charge - conventional propellant hybrid, or Electrothermal-Chemical (ETC)-conventional propellant hybrid.

PHASE I: Develop analysis tools and recommend a method of increasing propulsive efficiency. The approach can be a travelling charge, or some other suitable method. Provide an analysis or simulation of the performance improvement. Conduct any necessary bench-scale tests to establish the suitability of, for example, propellant materials.

PHASE II: Fabricate a demonstrator and prove the effectiveness of the method. A subscale demonstrator is allowable, if analysis shows how it will scale to full-size systems such as Navy 5"/62 Mk 45 Mod 4 gun and a future DD-21 155 mm gun.

PHASE III: Demonstrate the improved performance at full scale.

COMMERCIAL POTENTIAL: Approaches to modifying the velocity, density, and flow fields resulting from a burning propellant bed, needed to enhance the gun performance, are also applicable to improvements in other combustion processes, such as fluidized bed reactors. Approaches that develop fast-burning solid propellants (as opposed to achieving fast burning by using small grains) will lead to safer propellants for commercial applications such as small arms, fireworks, signaling, and air bags. (For example, a truckload of solid propellant increments will be less likely to be scattered on the highway if the truck were to overturn, compared to a recent truckload of black powder.)

REFERENCES:

(1) William F. Oberle, Constant Pressure Interior Ballistics Code CONPRESS: Theory and User's Manual. ARL-TR-199, Army Research Laboratory, Aberdeen Proving Ground, MD, September 1993.
(2) James T. Barnes and Edward B. Fisher, Combustion Mechanisms of Very High Burn Rate (VHBR) Propellant. ARL-CR-242, September 1995.

KEYWORDS: gun; propulsion; Lagrange gradient; travelling charge; interior ballistics; pressure

N00-058 TITLE: Direct Digital Signal Synthesizers

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: Develop a small, low-cost direct Digital Signal Synthesizer (DDS) for use in digital radar that generates high fidelity analog signals at high speeds from digital signals.

DESCRIPTION: In a "Digital Radar", digital T/R modules are physically located behind each radiating element in the radar antenna and only digital information is transferred over fiber optic links between the processor and the T/R Modules. Each digital T/R module converts a digital waveform to analog, frequency up-converts, amplifies and radiates it. After the radar echo arrives at the antenna, it is passes through a receiver protector, and the echo signal is down-converted in frequency, passed through an A/D converter, converted to base-band, and then transferred to the processor over the digital fiber optic link. A critical element in this described process is the direct Digital Signal Synthesizer DDS. Commercial units currently have large spurious responses.

A set of specifications are:

Intermediate frequency	45 MHz
Bandwidth	to 10 MHz
Waveform	Complex waveform with true time delay
Phase noise	-140 dBc/Hz
Spurious signals	110 dBc
Module-to-module	uncorrelated noise
Size	few small chips
Cost	$100

NRL has experimented with a delta-sigma 1 bit DDS Unit and has achieved -130 dBc/Hz on a 40 _5 MHz sinusoid with no readily noticeable spurs using a 960 MHz over-sampled clock and a 6th order encoder at an IF frequency of 40 MHz. NRL have also generated linear FM waveforms. It was also shown that by using dithering that the waveform noise from module-to-module is de-correlated. NRL believes that the delta-sigma encoding can be performed easily in a single FPGA for waveforms having 10% or less duty cycle. For continuous waveforms or the 1st LO, it appears that the encoding may be performed in real time in one or two large FPGA.

The requirement is to develop new high performance, small, and low cost DDS units. This could be done with a new technique or by expanding on NRL's described work on delta-sigma techniques. Other criteria that should be considered in the development are equalization, time delay, Phase shift, amplitude, etc.

PHASE I: Develop a design achieving the required performance among various alternative designs. A successful design will eliminate the serious spurs present in the performance of current Digital Synthesizer Designs, for which there is no satisfactory remedy.

PHASE II: Fabricate prototypes within the size and cost constraint and demonstrate their performance. A successful prototype will meet the size and performance requirements described herein and, if delta-sigma techniques are employed, provide the necessary improvements in high-speed delta-sigma operation(s).

PHASE III: Incorporate the DDS unit into the Navy Volume Search Radar (VSR) program, and into the Advanced Multifunction RF System (AMRFS).

COMMERCIAL POTENTIAL: These DDS Units could be widely used in the rapidly growing wireless communication industry. Law Enforcement Radar, Weather Radar, and NASA Remote Sensing Radars all could use these compact and cheaper DDS Units.

REFERENCES:
1. Example Vendor - Stanford Telecom, Lowell, MA
2. S. Norsworthy, R. Schreier, G. Temes, "Delta-Sigma Data Converters," IEEE Press, 1997.

KEYWORDS: VSR, DDS, Direct Digital Synthesis, D/A, low cost

N00-059 TITLE: ADVANCED REACTIVE MATERIALS AS PROPELLANTS

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: Develop high energy reactive materials as rocket propellants, fuels, and modifiers.

DESCRIPTION: High-energy propellants will allow the Navy to develop weapons systems with longer range, lower costs, and greater flexibility. Specifically, the range should be doubled and the fly-out time halved by the year 2005, as compared to the 1995 baseline.

Technology goals include the improvement of specific impulse and mass fraction of propellant for tactical missile and/or spacecraft propulsion. This may be accomplished by increasing the overall energy content and/or burning rates. For example, changing only the burn-rate from 1-2 inches per second at 1,000 psi to 10 inches per second at 5,000 psi without a pressure exponent change, would enable propulsion designers to eliminate the center perforation yielding more propellant per unit volume.

Reactive materials may also improve the combustion rates in ram-jets, ducted rockets, and hybrid motors. The reactive materials may include an energetic material consisting of two or more solid state or liquid reactants, that together form a thermal chemical mixture that could be used/for propellants and reactive components. Typically, reactive materials are metal-metal, metal-metal hydrides, and/or metal-metal oxide mixtures, with and without binders; included are thermites, intermetallics, metal/halogenated compounds, and ultrafine powders. Of interest are also ultrafine powders of complex compounds of boron, nitrogen, and hydrogen.

Research and development in this advanced topic should include maximum innovation and flexibility, while yielding promising commercial applications or dual-use technologies. Practical processing and manufacturing are also important.

PHASE I: The initial research and development effort will assess the feasibility of existing and proposed unique capabilities, and demonstrates through bench-scale evaluation the proposed new approach and payoff to be derived, by implementing the concepts/materials. The effort should be directed toward experimentally demonstrating potential systems suited for application as new rocket propellants, fuels, or modifiers. The effort would experimentally produce and test small quantities (grams) of the reactive materials or reactive materials incorporated into the propellants. Experimental methods may include differential scanning calorimetry, thermogravimetric analysis, and combustion bomb analysis to quantify the energy increase /improvements and the reaction rate enhancements.

Samples in gram quantities should be delivered to NSWD-IHD for evaluation and safety testing.

PHASE II: Will demonstrate selected reactive material advanced technological concepts beyond bench-scale, and conduct verification that doubling the range may be achieved, with halving of the fly-out time. The verification shall be done by quantitative measurements of improvements made in energy contents and burn-rates. Preliminary manufacturing and processing should be demonstrated. The energetic material should have application to civilian space technology and novel weapons technology. The material should be delivered in 20 kg batches to NSWC-IHD for evaluation and safety testing.

PHASE III: Optimize the materials for cost, performance, safety, and ease of manufacturing. The reactive material/propellant should have application to civilian space technology and novel weapons technology. The technology should transition to air/surface weapons programs.

COMMERCIALIZATION: Commercial potential exists in the fields of air independence propulsion and space vehicle launch/control. Spin-off technologies would include reactive material ultra-fast cutting in outer space. This technology could also be used underground in the cutting of oil-well casings. Presently, the oil-well industry is dissatisfied with explosive cutting of well-pipe in horizontal well-drilling operations.

REFERENCES:
1. Sergeev G. B., Petrukina M. A., Progr. Solid State Chemistry, Vol 24, p 183, 1996.
2. Borovinskaja I. P., Mendeleev Communications, pp 47 -48, 1997

KEYWORDS: Reactive materials; propellant; high energy; fuel; modifier

N00-060 TITLE: Aerodynamic range extension of guided projectiles

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: Develop methods to extend the range of guided gun projectiles by increasing their lift-to-drag ratio

DESCRIPTION: Current designs for guided projectiles for Naval Surface Fire Support are designed to achieve their required range through a combination of rocket assistance and gliding flight. The rocket motor has a negative impact on payload fraction, cost, safety, reliability, and testability. The NSFS program would like to eliminate the rocket motor from the projectile, while still meeting most or all of their range requirement.

This topic seeks improvements to the projectile aerodynamics, including lift enhancement and drag reduction methods, that will recoup most of the range lost by deleting the rocket motor from the EX-171 Extended Range Guided Munition design.

PHASE I: Develop an approach to improving projectile aerodynamics: increasing lift, reducing drag, or both. All aerodynamic surfaces and other equipment must fit within the 5-inch gun tube, folding if necessary. The volume of the current ERGM rocket motor and warhead bay is available for use, with the requirement that the volume of the warhead bay be preserved, although it may be shifted forward or aft, or (less preferably) divided into two bays of roughly equal size. Estimate the resulting range and time of flight performance for the projectile. PMS 429 desires that any simulations developed be integrated into the Phoenix Integration Corporation Model Center product, which allows integration of component models into a system simulation. Integration requires Phoenix Integration's "Analysis Server," which is currently available at no cost on the Internet, at http://www.phoenix-int.com/

PHASE II: Implement the improvement in a test projectile or airframe, and demonstrate the improved performance through gun-launched, wind tunnel, or drop tests that provide the same flight regime in which the improvement takes effect. (That is, if the improvement only affects subsonic flight, only subsonic tests are required, if the design permits confident belief that supersonic flight characteristics are unaffected.)

PHASE III: Integrate the improvement into an NSFS projectile.

COMMERCIAL POTENTIAL: Approaches to aerodynamic lift increase and drag reduction are fundamental to improved performance of civil aircraft and other vehicles, as well as other aerodynamic and hydrodynamic flow applications including turbine engines, air flow in building HVAC, and fluid flow in industrial processes. The particular requirements of projectiles for low cost, rugged mechanisms favor approaches that are suitable for commercial application as well. The specific application will depend on the approach the contractor takes, with approaches that improve subsonic lift-to-drag having application to commercial vehicles and duct air flow, while supersonic improvements would map to turbine engine applications, for example.

KEYWORDS: Range extension; lift; drag; aerodynamics; Extended Range Guided Munition; lift-to-drag ratio

N00-061 TITLE: Effect of Ocean Waves on Tracking Low-E Objects in Multipath

TECHNOLOGY AREAS: Human Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: Develop and validate a model for mono-pulse radar returns from a low-E target in the ocean environment, and fabricate a realistic multi-path simulator to study tradeoffs in tracking methods for low-E targets.

DESCRIPTION: The development method is based on three assumptions: (1) a two-component "composite" sea surface; (2) neglect of the component of earth curvature perpendicular to the antenna-target direction; (3) radially symmetric scatter of the electromagnetic waves form the tilted rough surface facet. The model will build upon and extend this framework or provide alternative formulations.

PHASE I: Develop a model of monopulse radar returns from a low-E target in multipath for a given frequency-direction ocean surface wave spectrum. Implement this model in software and test numerically. Incorporation and validation of the development assumptions into a working model is an inherent risk with this approach.

PHASE II: Link the multipath model developed in Phase I to a standard tracking scheme and test by tracking real low-flying targets (aircraft) with real radar over a real ocean. There is risk that testing in a real ocean environment may uncover unforseen difficulties.

PHASE III: Prepare a complete tactical system with manual and training program and install on ships.

COMMERCIAL POTENTIAL: Possible use by satellite probing the sea surface by radar; Use by commercial airports with landing approach over water; Use in determining ocean-wave parameters by monostatic or bistatic land-based radar.

REFERENCES:
1. Groves, G. W., and W. C. Chow, 1998: Glistening-region model for multipath studies. Proc. SPIE AeroSense Conference, Orlando, FL, April 1998.
2. Kinsman, B., 1965: Wind Waves: Their Generation and Propagation on the Ocean Surface. Dover (reprinted 1984).
3. Pierson, W. J., Jr., 1955: Wind Generated Gravity Waves. In Advances in Geophysics, vol. 2. New York Academic Press, pp 93-178.

KEYWORDS: Glistening; Ocean; Waves; Spectrum; Multipath; Radar

N00-062 TITLE: Force Level Automated Certification of Downward Compatible Baseline Software

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: Develop an Automated Test Capability (ATC) to provide automated re-certification of "Downward Compatible" computer programs baselines. A Downward Compatible computer program baseline adds one or a few new capabilities for addition of a platform and new external interfaces. A Downward Compatible Baseline also maintains the functionality and interfaces from the previous computer program baseline for the existing platforms such that there are no impacts to legacy systems when the legacy system baseline is upgraded for the new platform baseline. The ATC would ensure that the new baseline is in fact Downwards Compatible with the legacy systems (i.e., the new baseline did not impact the legacy systems). An ATC would provide significant cost savings during regression testing and re-certification of the multiple legacy combat systems that receive the new Downward Compatible Baseline computer program.

DESCRIPTION: For Force level types of systems, such as the Navy's Cooperative Engagement Capability (CEC), testing and certification of the multiple Cooperative Units (CUs) has expended a lot of resources as current test and certification processes are manually intensive. This SBIR topic addresses the need for an automated test process, specifically when a new baseline impacts only one type of platform/system (new/modified systems) while not impacting others (legacy systems). For example, when CEC creates a new baseline to integrate with a new platform (i.e., SSDS Mk 2), this typically entails adding new sensors and new combat system interfaces specific to that platform only. However, CEC must be able to generate common solutions across platforms, and today this requires that all CEC units in the Battle Force receive the latest CEC baseline. To allow the latest CEC baseline to be backfit with no impact to the legacy combat systems, the new CEC baseline is designed to be "Downwards Compatible" with the previous baseline. The platforms not impacted by the CEC baseline upgrade would be candidates for automated testing (regression and re-certification) since it is envisioned, and is the purpose of this SBIR topic, that the re-certification of all the legacy units could be automated using the ATC, thus saving extensive amounts of resources. The ATC would record the test procedures and results from the previous baseline test. After the new Downward Compatible baseline is developed and backfit to the legacy units, the ATC would be used to automatically re-run the test procedures against the Downward Compatible baseline, record the results and compare the results from the previous baseline test to the Downward Compatible baseline test. If the results are the same, then the ATC has validated that the Downward Compatible baseline did not impact the legacy interfaces and systems. If the results are different, then the ATC would record the deltas so that they baseline developer can take corrective action.

The intent of this SBIR is to define what needs to be done to Military systems, such as CEC and the combat system elements, to allow an ATC to simplify and reduce the time and cost of re-certification. It is anticipated that the ATC could be used as a basis for automated testing of any new baseline development after the first vessel in a ship class and not limited to Downwards Compatible baselines. This capability will be particularly important as the Navy begins development of the Common Command and Decision (CC&D) capability which, like CEC, will require backfit of common computer programs across the Battle Force with no impact to legacy combat systems. Typically, the legacy combat systems will far outweigh the systems being upgraded, so the cost savings of not having to manually test the new Downward Compatible baseline should be very significant.

PHASE I: Develop prototype ATC (described above) where fixes and/or baseline upgrades are made to a baseline and automatically re-certified to ensure that legacy systems and interfaces have not been perturbed. Analyze the CEC System and the host platform Combat System to support this ATC for CEC and host combat systems. Describe necessary changes to baseline development and testing philosophy within CEC and the host Combat System to support an ATC and show how these changes could be made across the systems.

PHASE II: Develop ATC tools and evaluate them on the CEC System and host platform Combat Systems baseline. Create a library of cases for future re-use. If complete ATC can not be achieved, describe what additional development is required to verify and certify that the new baseline is, in fact, Downward Compatible with the previous CEC baseline (i.e., does not impact the host

Combat System).

PHASE III: Extend the ATC tool to introduction of Commercial Off The Shelf (COTS) software to CEC, Combat Systems, Common Command & Decision (CC&D), Coordination Systems, or Force Level System of Systems.

COMMERCIAL POTENTIAL: Commercial software is continually upgrading its hardware and software operational base to add new platforms, operating system baselines, hardware interface drivers, etc which do no impact the basic functionality only add additional applicable equipment and processing compatibility. The ability to automatically test and re-certify existing baseline functionality when new interfaces and platforms become available is part of the commercial software expansion of the product base. Development of efficient and effective means of re-certifying the software for existing legacy systems will reduce time to market to use the latest hardware and software in the commercial marketplace. Since the Navy is also interested in utilizing the latest commercial products, as well, but has a more stringent testing requirement. Extension of the Navy's quality requirements into testing that can be used by commercial developers will raise the level of quality of commercial products and extend the product application to commercial applications, which have the same quality requirements as the DOD.

KEYWORDS: Automated Test Capability; Regression Testing; Re-certification; COTS; Availability; Reliability; Downward Compatible Baselines; Downward Compatibility

N00-063 TITLE: RECONFIGURABLE MAINTENANCE AND DIAGNOSTIC ASSEMBLIES (RMDA)

TECHNOLOGY AREAS: Materials/Processes, Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: Develop a re-configurable maintenance and diagnostic board assembly to support fielded systems based upon application of field programmable gate arrays (FPGAs). RMDA boards may be reconfigured as either Maintenance Assist Modules (MAMs) modules/boards, spare parts for interim repairs, or as a diagnostic tool for determining unique operating problems. RMDAs that reduce the required onboard inventory of special-purpose unique designs, and ultimately reduce the overall operation and support (O&S) costs, are desired.

DESCRIPTION: All shipboard electronic systems employ multiple, special-purpose unique design components. Each of these unique designs must be carried in inventory as MAMs or spare parts for interim repair. These same systems can sometimes exhibit unique operating problems which must be dealt with quickly. Getting the manufacturer's test equipment and personnel to the site would be the best solution, but is not always practical. This problem could be resolved if identical diagnostic board assemblies were available to the field operator and to the manufacturer.

To support the mulitiple application of RMDAs (as MAMs, Spares, or diagnostic tools), it is suggested to utilize FPGA technology and reprogrammable read-only memory and apply them to the RMDA's design.
This solution offers advantages over a generic diagnostic board. A manufacturer will be able to re-program any software that will reside on the board, but it will also re-program any hardware elements that they believe will be necessary to perform the diagnostics and then transmit the changes to the field for immediate testing of the system. To summarize, the manufacturer will be able to tailor what is available out in the field to the problem at hand.

The benefit of reducing onboard inventory of special-purpose unique designs is expected to be dramatic; further benefits resulting from just-in-time repairs/troubleshooting would also accrue. Additionally, because these reconfigurable MDA's may be programmed repeatedly, a reduced number of both customary MAMs and spares are expected.

PHASE I: Develop RMDA preliminary designs, and identify the shipboard electronic systems and the associated special-purpose unique design modules suited for application of RMDAs. Identify the number of required programmable electronic modules needed to assist maintainers in the repair of shipboard electronic systems and also the systems using the RMDA diagnostic board. Calculate the cost benefits associated with the use of RMDAs.

PHASE II: Design, prototype, and demonstrate one or more programmable electronic modules to implement the RMDAs. Using the RMDAs, conduct an onboard proof-of-concept with one or more electronic systems through an underway, operational period.

PHASE III: Design additional RMDAs for transition within the Navy laboratories. The contractor will support the Navy laboratories and production of the RMDAs through a specified period under a Phase III award.

COMMERCIAL POTENTIAL: The use of RMDAs has direct application in the commercial electronic service sector. The reduced inventory of RMDAs provides an innovative solution for service representatives. (The reduced inventory results in a reduced cost of outfitting service representatives.) Also, the use of re-configurable board assemblies for the identification of field problems could be utilized by the service sector. Local representatives may download the necessary programs for diagnosing problems within large systems. The main manufacturing plant would not have to send their experts out to the field.

TECHNICAL RISK: The primary risk is to ensure that the performance of the RMDA is comparable (or improved) to the original MAM or spare it is replacing. The only other risk involved would be to ensure there are no special environmental requirements in existence for the MAMs or spares that would be replaced by the RMDAs. (i.e., Shock or other military specific requirement which could negate the use of COTS components. Such systems may not be a candidate for this proposal.)

REFERENCES:

1. IEEE Std 1076-1993, IEEE Standard VHDL Language Reference Manual (LRM) copyrights 1993 by the Institute of Electrical and Electronics Engineers, Inc.
2. Douglas L. Perry, "VHDL", second edition, McGraw-Hill, New York, 1994.
3. Zainalabedin Navabi, "VHDL Analysis & Modeling of Digital Systems", McGraw-Hill, New York, 1993.
4. Lisa Maliniak, "A Beginner's Guide to VHDL", Electronic Design, pp. 75-82, October 14, 1994.

KEYWORDS: Reconfigurable; MAM; spare parts; diagnostic; programmable; electronics; maintenance; VHDL

N00-064 TITLE: Miniature RF Filters

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: The objective is to develop miniature RF Filters.

DESCRIPTION: Radars use super-heterodyne up/down frequency conversion processes in their receivers and exciters. The components for these devices have dramatically decreased in size over the years and are now mounted on microwave boards using surface mount technology. The amplifiers and mixers are quite small leaving the filters to be by far the largest element. The size of these parts become even more important in a "Digital Radar" because the up/down frequency conversion process is performed behind each radiating element. In the Digital Radar only digital information is transferred over fiber optic links between the processor and each Digital T/R Module located behind each radiating element in the radar. In these cases it is highly desirable to reduce the size of the filters so that very little space is utilized in a Digital T/R module.

An example of filters under consideration at NRL for a L-Band Digital T/R Module are as follows. Currently NRL uses 4th to 6th order filters at frequencies such as 45 MHz, 915 MHz, 1300 MHz, 2200 MHz, whose size tends to be on the order of 1 1/2" long by 1/2" x 1/2". The filters requirements are on the order of 1% to 10% bandwidths, 100 dB out-of-band rejection, a few dB insertion loss and 4th through 8th order filters. Furthermore, no parasitic resonance's are allowed up to a frequency of 20 GHz. Finally, we would desire filters on the order of a size of 1/2" x 1/2" x 1/4", and the cost in large production to be on the order of $25 a piece.

PHASE I: Develop a design achieving the required performance among various alternative designs. There is high risk in constructing miniature RF filters. All filters to date are all larger than desired. Consequently a new technology is required.

PHASE II: Fabricate prototypes within the size and cost constraint and demonstrate their performance. A successful prototype RF Filter will meet the size and performance requirements described herein and develop any necessary new fabrication technology; there is high risk in constructing miniature RF filters based on new technologies.

PHASE III: Incorporate the filters into the Navy Volume Search Radar (VSR) program, and into the Advanced Multifunction RF System (AMRFS).

COMMERCIAL POTENTIAL: These filters could be widely used in the rapidly growing wireless communication industry. Law Enforcement Radar, Weather Radar, and NASA Remote Sensing Radars all could use these compact and cheaper RF filters.

REFERENCES:

1. Example Vendor - Lorch Microwave, Salisbury, MD
2. J. Browne, "Technology Fuels Firm's Entry into Filter Market," Microwave & RF, Jan 1999.

KEYWORDS: VSR; RF filters; miniature; low cost; radar; module

N00-065 TITLE: High Velocity Combustion Processes in the Solid State

TECHNOLOGY AREAS: Weapons

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: Develop and demonstrate a technological process for achieving ultra-high rates of combustion of the solid-solid type.

DESCRIPTION: Solid-solid exothermic reactions can proceed in three important modes: slow combustion (cm/s), fast combustion (few hundred meter per second) and detonation (km/s). The theory of slow combustion (sometimes also called SHS) is well developed. However, theory of fast combustion and detonation is in its infancy. Of interest is the theoretical development of the phenomenon of fast combustion and detonation (solid-solid), which should be further studied in systematic experimental activity.

PHASE I: The effort should be directed toward theoretically demonstrating the conditions which will lead to ultra-high rates of combustion (solid-solid). The theory should provide a model along with a typical solution. The theory should also include the mechanism of compaction of porous mixture of reactive powders with appropriate equations of state.

PHASE II: The effort should develop experimental techniques to prepare the reactive mixtures and carry out the combustion and detonation experiments. It is supposed that the contractor will carry out the experiments in the facilities of NSWC-IHD. The Phase II should gather enough experimental and theoretical data necessary for scale-up in Phase III.

PHASE III: Military applications that would benefit from this technology encompass propellants, explosives, pyrotechnics, and reactive materials. This technology should transition into Air and Surface Weaponry programs.

COMMERCIAL POTENTIAL: The mining industry can tremendously profit by having very powerful low-cost explosives available. The ultra-fine materials resulting from this combustion technology development, would, after sintering, result in super-plastic ceramic materials which are currently not commercially available. These materials are of interest to the automobile, aerospace, and metal processing industries.

REFERENCES:
1. Enikolopyan, N.S., "Super-fast Chemical Reactions in Solids," Russian J. Phys. Chem. 63 (9) pp. 1261-1265 (1989).
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3. Enikolopyan, N.S.,et al., "Explosive Chemical Reactions of Metals with Oxides and Salts in Solids", Doklady Akad. NAUK SSSR 294 912 (1987)
4. Enikolopyan, N.S., "Detonation as a Solid Phase Chemical Reaction", Doklady Akad. NAUK SSSR 302 630 (1988)
5. Gogulya, M.F. et al., "On the Characteristic Times of Chemical Reactions in Heterogeneous Systems under Dynamic Load", Khim. Fiz. 13 88 (1992)
6. Viljoen, H.J. and V. Hlavacek, "Deflagration and Detonation of Solid-Solid Reacting Systems", AlChE Journal 43 (11) pp. 3085-94 (1997).

KEYWORDS: Combustion; detonation; solid-state combustion; solid-state detonation

N00-066 TITLE: Operator Assistant for Artillery-Launched Observation Round

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: Develop an automated assistant to improve the operational effectiveness of the operators of "ALOR" Artillery Launched Observation Rounds.

DESCRIPTION: ALOR is a joint Army-Navy technology demonstration using gun-launched aircraft to function as targeting sensors and loitering munitions. As observers, these munitions will provide target confirmation, target location error reduction, battle damage assessment; as weapons, they will deliver bomblet payloads, providing fast-response firepower similar to an organic mortar squad. The technology demonstration is focusing on producing a flight-worthy airframe and sensor package; this topic seeks complementary development of prototypes of an operator's assistant for these rounds. Some functions that would be desired in the assistant include

- Navigation, airspace management, and deconfliction-assist the operator in keeping the aircraft positioned clear of other air traffic, out of high-threat areas, while maintaining a responsive station to support friendly maneuver units and gather needed targeting information.
- Information management assistance-Allow storage, processing, review and replay of sensor data gathered, assist in extraction of tactical information from the sensor data, and facilitate reporting. Effort in this area should stress interoperability of the system with multi-service and multi-agency information reporting requirement.
- Target location and identification assistance-use Automatic Target Identification and Region of Interest Identification methods to cue the operator to potential targets. The ultimate objective is to permit the operator to more efficiently employ these aircraft for targeting and weapon delivery, so that each aircraft can generate the most tactical data and attack targets as responsively and effectively as possible, and to allow each operator to control multiple aircraft. The challenge is to produce an assistant that is seamless and efficient, not cumbersome or distracting, for an operator using a new type of weapon for which there is little operational

experience or prior development. A successful assistant will relieve the operator of workload in navigating and employing the ALOR, allowing him to make best use of it and avoid unnecessary losses or mishaps.

PHASE I: First, select the capabilities to implement: Establish a set of high-payoff capabilities for a prototype ALOR operator assistant will provide. Base the selection of areas where the prototype will provide assistance on an assessment of the workload of an ALOR operator, with particular attention to the areas where ALOR operations differ from UAV operations. Assess the feasibility of current technologies in information display; expert systems; geographic information systems; navigation and routing; and video exploitation to support the prototype design. Then, develop a prototype design: produce a system design the incorporate and integrate the selected capabilities into a prototype assistant.

PHASE II: Implement the prototype Operator's Assistant, and conduct usability trials with operators. Incorporate feedback from these trials in improvements to the Operator's Assistant, in a spiral development or rapid prototyping development model. The intention of Phase II is to produce functional modules, which can be transitioned into ALOR and UAV control programs, and into similar commercial products, as needed by the military programs and the commercial market. Therefore, effort should be focused on component functionality, and not on producing a full-featured, finished product.

PHASE III: Incorporate the Operator's Assistant modules into the ALOR control system.

COMMERCIAL POTENTIAL: The algorithms and methods needed for this topic have applicability in a variety of areas, which include (1) automobile navigation and geographic information systems; (2) field data collection, especially management of video as data, in areas that include construction, forensics, traffic monitoring, and journalism; (3) machine vision; (4) aircrew workload management and air traffic control in "free-flight" operations.

REFERENCES:
1. Artillery Launched Observation Round program briefing
2. Naval Surface Fire Support Concept of Employment

KEYWORDS: assistant; software; flight control; navigation; situational awareness; aircraft

N00-067 TITLE: Upward Compatible Baseline Support Framework For Effective Force Level System Regression Testing and Certification

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Theater Air Defense and Surface Combatants

OBJECTIVE: To develop an Automated Certification Capability (ACC) by defining a Modularization process and set of logical baseline definitions and developing the associated Systems Engineering tool set to simplify and automate developmental, certification, and operational testing of Force level systems in a system of systems environment.

DESCRIPTION: Force level system of systems developmental, certification, and operational testing is very time consuming and manpower intensive. The variations and changes in interfacing systems for Force level system of systems requires constant configuration management upgrades using the current set of acquisition process concepts and approaches. Therefore, testing continuously changes as the baseline configurations change at the developmental, certification, and operational levels for each system in a system of systems environment is required. Automation can help make the testing at each of these levels more effective and efficient but it will require a repeatable and logical set of baseline definitions and a consistent Modularization process across Force level system of system developments, which meet the needs of systems in a Force level structure.

The goal of this SBIR topic is to develop an ACC. The ACC will include: definition of a Modularization Process, a Logically Related Force Level System of Systems Baseline Definitions, and associated Systems Engineering Tool Set to automate the design, development, testing, and certification of each system in a Force Level Structure to fit into an upward compatible baseline framework like commercial systems use. Through the Modularization Process, the Systems Baseline Definitions, and Systems Engineering Tool Set (which are developed to support the Process and Baselines) we will be able to design Interoperability into systems in the Force structure. The modularization process applies to each system and also seeks to ensure similar modularization of functions across Force level systems. Designing in and verification of Interoperability at each stage of the process will be similar to the Upward Compatibility framework for commercial systems and software. Commercial systems and software use different baselines for major functional upgrades, minor functionality upgrades, and maintenance baselines. This SBIR topic will include a significant new area, for DOD systems will be addressing modularity of threat upgrade impact on real-time system of systems types of designs. Commercial software developers are integrating previously developed applications into integrated software suites (Office 98) for data processing types of applications. The application of these concepts for real-time Force level integrated system of systems applications is a void that must be addressed for DOD systems.

A by-product of using commercial upward compatible concepts in Force level system of systems types of developments is a statically and dynamically reconfigurable baseline suite of programs. Using a survey of platform hardware and software configuration and hardware and software configuration of interfacing to determine the appropriate configuration, the actual software for the site can be built, loaded, and tested on site.

PHASE I: Research the philosophy, techniques, and concepts used by commercial system and software developers which support Upward Compatible Baselines and how this can be used for DOD systems. Research the automation of developmental, certification, and operational testing in Upward Compatible Baseline commercial systems and where this can be applied to DOD systems. Research how commercial systems modularize to support this automation and how this impacts delivery baselines. Can these approaches be used by DOD? Research commercial capabilities which survey the platform, operating system, and interfacing systems for commercial software suits and select a configuration of the software suite which will work on the system configuration discovered during the survey. Can this type of structure solve the configuration management issues for Force level system of systems for Interoperability?

Research how commercial systems load and link the selected configuration and then test the configuration before providing the operational system to the user. Can this approach be used to ensure Interoperable Force systems? Select a Force level system, like the CEC program, and apply the lessons learned to the modularization and baseline concepts for the selected system. Write up a report on the concepts discovered and what would need to be done to the selected DOD system to provide capabilities similar to those of the commercial system.

PHASE II: Extend the results from Phase I to definition of a Modularization Process, the Logically Related Force Level System of Systems Baseline Definitions, and associated Systems Engineering Tool Set to automate the design, development, testing, and certification of each system in a Force Level Structure to design Interoperability into the process. Expand the definition of the process, baselines, and tool set to address the unique threat upgrade requirements based on the history of the threats against the system selected in Phase I. Write specifications for the ACC to include the modularization process, its associated logical baselines, and Systems Engineering Tool Set for development of these tools during Phase III. Apply the results to the selected system for future baseline development.

PHASE III: Develop the integrated ACC Systems Engineering and Certification tool set specified in Phase II and apply to the next system baseline for the system selected in Phase II. Extend to COTS implementation of the baselines for the selected DOD system and show how this can be applied to the commercial market place for real-time highly reliable critical systems.

COMMERCIAL POTENTIAL: Commercial software developers, for data processing types of application suites, have integrated software packages developed in isolation initially into integrated packages (like Office 98). Commercial software applications have instituted an upward compatibility framework for software baselines to make sure that software will work on old configurations with the same capabilities expected in earlier releases. Testing of the earlier baseline capabilities can be automated to make the certification of upward compatible baseline software possible in the turn around time allowed between baselines. The automated approaches are extended to development of new baselines that are upward compatible. To make upward compatible baselines that can be tested automatically require some standardization of approaches, architectures, and modularity between baselines to simplify regression testing. The real-time processing areas have lagged behind the data processing areas in the upward compatible baseline and automatic testing area. Real-time processing applications are basic in DOD systems. This SBIR is addressing Upward Compatibility and automation of testing and certification for DOD real-time Force Level types of applications. Force Level application integration is a similar problem to integration of data processing applications into a suite of applications.

Commercial software does not have the same level of quality control and certification sophistication of DOD systems for real-time systems. Integrated COTS packages from commercial sources do not provide the level of availability and reliability as DOD developed packages. There are commercial segments, which have the same operational levels of these factors as DOD. These segments can not afford the developmental costs of testing and certification packages as DOD because of market size. Since it is in DOD's interest (and will be beneficial to raise the level of performance of COTS in standard ways), the commercial sector will benefit from DOD developed testing and certification techniques. The commercial benefit of automating certification and operational testing of COTS will yield higher levels of operational performance for all interested parties, both DOD and commercial developers. Automatic certification and operational testing processes at DOD levels of sophistication for commercial products could be extended after seed SBIR research baselines the process. Standardizing the Modularization process and baseline definitions could allow standardized automation of testing and certification, which will benefit both commercial and military segments.

KEYWORDS: Automated Certification Capability, Efficient Automated Regression Testing; COTS; Efficient Structured Automated Certification; Availability; Reliability; Upward Compatible Baseline certification.

N00-068 TITLE: <u>Flexible Sound Source</u>

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Undersea Warfare

OBJECTIVE: The Navy and private industry use acoustic energy to detect and locate objects in the ocean (fish) and on the ocean floor (rocks and wrecks). The most versatile systems for this purpose are towed line systems that stream aft of the towing ship. Towed line systems consist (in sequence) of a flexible cable, a sound source, some additional flexible cable, and a receiver. Presently, the sound sources are rigid and are disconnected from the flexible cable as the towed line system is retrieved. This is labor-intensive, and if the cable is long, may pose a personnel hazard under adverse sea conditions. The solution to this difficulty is the development of flexible acoustic sound sources that may be reeled unto the winch drum along with the tow cable and receiver. The sound source must efficiently transmit sound to the water with a decade of bandwidth, and adapt to and compensate for cable motions and strumming to maintain an omni-directional pattern in the sound band. Present cable arrays are recieve only.

DESCRIPTION: The Navy is interested in a flexible broad-band sound source that meets the objectives and may be reeled unto a winch drum of 20 inches or larger diameter. The broad-band sound source must have provisions to pass fiber-optic and power leads through to the down-stream sound receiver. The frequency range for the broad-band sound source must be from less than 10 kHz to greater than 100 kHz with an equivalent acoustic source level of 186 dB ref 1uPa at 1 meter from the array. The source must be capable of transmitting four simultaneous tones of 180 dB each, at frequencies not harmonically related, within the band. The transmit pattern must be omni-directional (+/- 3 dB) at all frequencies. The sound source must be capable of withstanding 20,000 lbs tensile strength (cable tension) and have a diameter of less than 4 inches.

PHASE I: Design and develop a flexible sound source that conforms to the description and requirements, and perform tests and studies as required to confirm feasibility of the proposed design to satisfy the described requirements.

PHASE II: Construct a prototype based on the Phase I design that will meet the requirements in the description and conduct tests to demonstrate the prototype's characteristics.

PHASE III: Fabricate additional prototype(s) for test and evaluation as upgrade replacement components of the AN/SLQ-25A system.

COMMERCIAL POTENTIAL: A large commercial market exists for ocean surveying equipment such as side-scan and sub-bottom profiling. The flexible sound source, when coupled with available towed line systems, will make significant improvements in the ability to survey the ocean floor with economically feasible equipment.

REFERENCES:
1. "Scientific and Engineering Studies - Sonar Transducer Fundamentals", by Ralph S. Woollett, Naval Undersea Warfare Center, Newport, RI, 1984.
2. "Introduction to Ocean Engineering", edited by Hilbert Schenck, Jr. (University of Rhode Island), McGraw-Hill, Inc., 1975.

KEYWORDS: Acoustic; flexible; towed; transducer; winch; omni-directional.

N00-069 TITLE: Multi-Static Active Sonar Processing with Unknown Transmission Type and/or Unknown Source Location

TECHNOLOGY AREAS: Information Systems, Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Undersea Warfare

OBJECTIVE: Develop reliable active sonar processing techniques that exploit the availability of randomly occurring energy emissions (e.g., seismic exploration air guns, foreign sources, biologics or friendly sources) without knowledge of transmission type and/or provide for target localization when the active source or location is not known. The capability proposed under this topic does not exist within any existing Navy sonar system. Several unique new capabilities are required. These include the identification of random occurring acoustic signals from unknown sources occurring within the sea as 'exploitable'. Also included is the characterization of such signals in order to perform detection (i.e., form replicas or models of unknown signals); and finally the processing of signals arriving from unknown locations and extract information from the multistatic returns of such sources.

DESCRIPTION: Utilization of hostile or friendly sources without a-priori knowledge of transmission type and/or source location for active sonar processing can provide valuable tactical information to submarines operating near sources of opportunity. Random sources are not uncommon, including seismic exploration air guns, biologics, and active sonar, which ensonify the ocean and reduce the stealth of submarines in the region. Without the opportunity to process these multi-static active transmissions, submarines would be at a disadvantage relative to hostile submarines with this capability. Use of these sources for active processing presents several technical challenges. The fundamental technical challenge is real-time characterization and use of the transmission. The Navy is seeking algorithms and tools that permit reliable identification and utilization of these transmissions in a manner appropriate for use in real-time systems. The processing algorithms must include the capability of differentiation between transmission types such that the appropriate processing path in an active processor can be selected in real-time. Hydrophone saturation and distortion and its effect on real-time replica generation and classification must be addressed. Channel and source uncertainty must also be addressed.

When non-cooperating active sources are being exploited or when communications with a cooperating active source are not available, the location of the active source will not be known. Accurate source localization is necessary for accurate target localization and for optimal positioning of the receiver. The capability to localize the transmitter is therefore a necessary component of a multistatic concept of operations. The Navy is seeking algorithms and tools that permit reliable localization of active sources in a manner appropriate for use in real-time systems. Several factors must be taken into consideration, including bathymetric features and reverberation properties of the region. The tool should include algorithms for both automated source localization and manual verification by the operator. Consideration should be given to hydrophone saturation and distortion at direct blast time of arrival, the effects of array curvature and instability, and the ability to integrate the proposed algorithms into a real-time system.

PHASE I: Investigate and develop a set of algorithms useful in determination of source type (and extracting an appropriate replica) and/or source, and establish their performance based on simulated data.

PHASE II: Design and develop a prototype multi-static active processor for Navy evaluation. Using Navy-provided multi-static active tape archive data, investigate and select algorithms for use by the processor.

PHASE III: Successful algorithms will be integrated into a Navy real-time multi-static active processor. In addition to Navy use, multistatic techniques could be of use in the commercial and research arenas for tracking marine mammals across very long distances (since the location of the source and transmission types would often be unknown for these creatures).

COMMERCIAL POTENTIAL: The techniques developed under this topic would be applicable to many situations involving complex localization and classification of sources. Examples include whale tracking across ocean basins, air traffic control, weather radar, seismology, and law enforcement.

REFERENCES:
1. Isabel, M.G., Lourtie and G. Clifford Carter, "Signal Detection in the Presence of Inaccurate Multipath Time Delay Modeling," J. Acoust. Soc. Am., 88(6):2692-2694, December 1990.
2. Ainslie, C.H., et al., "Signal and Reverberation Prediction for Active Sonar by Adding Acoustic Components," J. Acoust. Soc. Am., 143(3), June 1996.

KEYWORDS: Acoustic Propagation; Shallow Water Acoustics; Multipath; Recombining; Sonar; Signal Processing; Multi-static Active; Bistatic Active

N00-070 TITLE: <u>Innovative Broadband Signal Processing Algorithms</u>

TECHNOLOGY AREAS: Information Systems

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Undersea Warfare

OBJECTIVE: Develop broadband signal processing algorithms capable of utilizing a nominal bandwidth of 2.4 to 50 kHz that can significantly improve effectiveness of active sonar in littoral environments. Existing Navy sonar systems can not exploit bandwidths of such extent and use of such large bandwidths for active sonar has not been previously demonstrated. This will require innovative signal processing (e.g., sub-band processing) and reverberation rejection.

DESCRIPTION: Undersea warfare operational requirements have recently shifted emphasis from the deep, blue water environment to the shallow, littoral environment. Additionally, threats have reduced radiated noise and improved acoustic capabilities, including enhanced countermeasure suites. These changes necessitate the use of advanced signal processing algorithms capable of meeting the augmented challenges of detection, classification, and localization of acoustic targets in shallow waters. Broadband processing, rather than narrow band, can accomplish these goals. Large bandwidth waveforms, however, present several technical challenges for the receiver processor, including spatial and spectral coherence, array gain variability versus frequency, spectral normalization, reverberation rejection, and contact classification. Additionally, processor throughput and implementation costs represent significant implementation issues. Proposals are sought for high performance advanced sonar signal processing techniques for broadband systems covering the 2.4 to 50 kHz frequency range. Both mono-static and multi-static processing are of interest. Methods to consider when identifying and developing these innovative broadband signal processing algorithms include the use of Chaotic Frequency Modulation (CFM, which has properties of a nearly ideal "thumb tack" magnitude squared wideband auto-ambiguity function and good suppression of distributed reverberation), the use of a modern cycle-octave wavelet time-frequency processing technique to coherently process the received signal across several octave bands, and the accurate simulation of the medium frequency (MF) broadband acoustic environment.

PHASE I: Formulate the theoretical basis for candidate innovative algorithms. Develop a prototype to illustrate basic operation and technique. Estimate or compute performance bounds. Assess software and hardware system requirements with an emphasis on low cost, commercial, open standard-based computing architectures.

PHASE II: Specify and develop a near real-time version of the algorithm(s) for a laboratory test bed. Run the algorithm software on simulated test data, or, if available, real sensor data. Compute performance statistics and document the operating range or effectiveness of key tuning parameters.

PHASE III: Refine the algorithm(s) based on Phase II results. Migrate prototype algorithm(s) to selected Navy systems for extensive in-water testing.

COMMERCIAL POTENTIAL: Techniques developed for this objective may have significant application to other fields that use active signal probing or broadcast and receive technology. Examples of commercial applications include medical imaging, seismic geophysical exploration, bottom contour mapping, fish finding, obstacle avoidance for large ships, and cellular telephone management of complex radio wave propagation.

REFERENCES:

1. Refer to the Office of Naval Research's Undersea Warfare Broadband Processing Working Group list of Broadband Processing References at http://www.onr.navy.mil/oas/info/harned/referenc.htm.

2.' Lightweight Broadband Variable Depth Sonar (LBVDS) Sea Test A Quick Look Report", 6 June 1997, Naval Undersea Warfare Center, Newport, RI.

3. Knight, W. C/, Pridham, R. G., Kay, S. M., "Digital Processing for Sonar", Proc. IEEE Vol. 69, No. 11, Nov. 1981.

KEYWORDS: Broadband: Algorithms; Software; Signal Processing; Sonar; Reverberation.

N00-071 TITLE: Advanced Automated Sonar Operator Machine Interface

TECHNOLOGY AREAS: Information Systems, Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Undersea Warfare

OBJECTIVE: Develop an advanced Operator Machine Interface (OMI) that will incorporate 3 dimensional (3-D) graphics and provides automatic graphical displays so that a dedicated operator is not required at each console/display. Utilize new display formats which convey the significant detection, classification, and localization information and do not inundate an operator with extraneous data, and maintain sufficiently low false alert rates so that a single operator can man an entire sonar watch.

DESCRIPTION: This effort will develop an automated OMI for acoustical data displayed on tactical sonar systems, using techniques potentially applicable to all undersea warfare platforms. The desired OMI will display automatic alerts for significant events received over appropriate interfaces (e.g., threat detections). Where possible, automation will be provided, thus freeing ship's personnel for other tasks. New display formats will be developed that present sensor data in a manner such that a typical person can interpret it without the need for extensive sonar training or experience. The use of graphical displays and 3-D graphics in a user-friendly and easily understood OMI environment is envisioned.

PHASE I: Develop the automation of alerts, new display formats based upon advanced graphics and 3-D, and conduct a demonstration of the benefits and capabilities of the new.

PHASE II: Construct and laboratory test a prototype automated OMI. Government furnished data, recorded during at-sea operations, will be provided for the test sequence.

PHASE III: Interface the new OMI with candidate sonar systems via the Advanced Build Process.

COMMERCIAL POTENTIAL: 3-D graphics, Virtual Reality, computer games (displays and OMI)

KEYWORDS: Sonar; Displays; Automated Alerts; Operator Machine Interface; Advanced Graphics; 3-D Graphics

N00-072 TITLE: Multistatic Acoustic Source for Unmanned Underwater Vehicles (UUV)

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors/Electronics/Battlespace

DOD ACQUISITION PROGRAM SUPPORTING THIS TOPIC: PEO Undersea Warfare

OBJECTIVE: Demonstrate the feasibility of integrating an acoustic projector with a torpedo sized UUV. The projector is to be capable of producing an acoustic source level of at least 205 db per microPascal @ one meter (higher source levels are advantageous) in the frequency domain of 300 Hz to 500 Hz with signal and power provided by the UUV (self contained). Such an acoustic signature would support use of the UUV as a multi-static source.

DESCRIPTION: Unmanned Underwater Vehicles carrying low frequency acoustic sources will provide a mobile maneuverable source for multistatic target detection operations in shallow water areas. The focus of this effort is on technologies associated with transduction and appropriate signal power amplification needs when constrained to operate in a torpedo sized UUV testbed. High transducer efficiency is critical to UUV needs. The acoustic projector should have directionality capability and be size and weight constrained to operate in mobile unmanned undersea vehicles. It is advantageous that the acoustic system has the capability to output a variety of waveforms.

PHASE I: Develop a new, low cost, high source level, size/weight constrained, and directional acoustic source with appropriate power amplification system. Conduct parameter modeling as needed to verify assumptions.

PHASE II: Fabricate and conduct in-water tests on a prototype system demonstrating its acoustic capability as a stand-alone system.

PHASE III: Integrate the prototype acoustic system into a UUV. The technologies developed and demonstrated will transition directly into the Mission Reconfigurable UUV Program (Program start FY03) sponsored by PMS403.

COMMERCIAL POTENTIAL: Acoustic source for conducting underwater geophysical/seismic surveys. Application of this technology to underwater geophysical/seismic surveys would be environmentally friendlier than present day methods.

KEYWORDS: Multistatics; Unmanned Undersea Vehicles; UUV; Underwater Acoustic Source; Underwater Acoustic Projector; Littoral Warfare.

N00-073 TITLE: Advanced Compression for Digital Terrain Elevation Data

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop new compression capability for digital terrain elevation data that preserves important terrain information, guarantees geographical and topological accuracy of the compressed data, and enables efficient reconstruction of the data as well as exploitation of compressed data directly.

DESCRIPTION: Digital terrain elevation data is an indispensable source of information for applications that use geo-spatial information. It requires very large amounts of memory, for example, it requires 18.5 MB to cover a 2km x 2km area with 1 meter resolution. This puts significant strains on bandwidth during transmission and computer storage as well as manipulation of the data. While existing compression technologies have been demonstrated to be useful tools for image compression, these technologies have not exhibited high fidelity for compressing digital terrain elevation data. The current challenge is to create a new compression methodology with a data representation scheme that exploits the peculiarities of the digital terrain elevation data to effectively compress the data while preserve important terrain information without distorting geographical and topological accuracy.

PHASE I: Investigate the mathematical characteristics of the digital terrain elevation data. Provide rigorous mathematical analysis on data structure and metric suitable for compressing such data. Provide an assessment on achievable levels of compression.

PHASE II: Develop and validate data structures and compression techniques with associated optimal metrics that are capable of preserving feature and removing noise; that allows accurate and efficient reconstruction of the terrain for analysis and visualization; and that enables direct manipulation with compressed data coupled with other image processing tasks, updating the master terrain database, and multi-resolution terrain data search / retrieval. Develop a realistic software prototype demonstrating these capabilities.

PHASE III: Prepare commercial products for use by civilian and military geo-spatial information analysts in terrain analysis and visualization and generation of maps.

COMMERCIAL POTENTIAL: The technology and product developed will benefit anyone who generates or uses maps. Applications range from all-weather autonomous navigation, autonomous landing system for commercial aircraft, flight simulation, mapping of planet surfaces, to virtual travels via 3D fly-through over the Internet.

KEYWORDS: Compression; digital terrain elevation; data structure; optimal metrics; geographically accurate; topologically accurate

N00-074 TITLE: Modeling and Simulation of Decision-making Under Uncertainty

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop software tools that will model, analyze, interpret, and simulate the process of human decision-making in operational and tactical situations and in the presence of uncertainty and stress.

DESCRIPTION: The human decision-making process under stress and in the presence of uncertainty is a complex phenomenon. Commercial knowledge-based system technology has proven successful for decision making in an environment with relatively little uncertainty and low stress, but can not support broad ranges of observations and actionable conditions, typical of the modern military environment and of many industrial and medical situations. The Navy's Tactical Decision Making Under Stress (TADMUS) program was tasked to define the tactical decision problem, to develop measures of performance for tactical decision making and to collect data to analyze the impact of stress. Based on this work there is a sufficient understanding of decision-making under stress to formally model the underlying process. The SBIR project described here seeks to explore new technologies, e.g., algorithms, computational methods, visualization concepts, etc., to model and automate aspects of decision-making, especially under time constrained conditions or conditions of excessive uncertainty.

PHASE I: Describe and develop the algorithms, techniques and system design for tools that will model and simulate the process of decision-making under uncertainty and stress.

PHASE II: Develop, implement, and validate a system that extends the understanding of human decision-making under uncertainty and stress to provide accurate complex process behavioral prediction. This should include the ability to visualize complex interactions of critical components leading to rapid human understanding of the situation.

PHASE III: Implement the models and algorithms in a comprehensive package that would include an intuitive graphical user interface (GUI). Transition possibilities include the Testing Experimentation Assessment Modeling and Simulation facility at NSWC, Dahlgren Division and the Marine Corps Warfighting Lab.

COMMERCIAL POTENTIAL: These tools would be useful for analyzing decision-making situations in the civilian sector and for training the decision-makers. Some examples of where these occur are financial companies (e.g., risk analysis, investment strategies), air traffic control, and national security intelligence analysis, all of which must attend to a broad range of observations, information, and actionable conditions that cannot be enumerated beforehand.

REFERENCES:
1. J. Cannon-Bowers, & E. Salas, (eds.), (1998), Making Decisions Under Stress, Implications for Individual and Team Training, American Psychological Assoc., Washington, DC.
2. C. Zsambok & G. Klein (eds.), (1997), Naturalistic Decision Making, Erlbaum, Hillsdale, NJ.
3. W. Zacahary, J. Ryder, and J. Hicinbothom, (1998), "Cognitive task analysis and modeling of decision making in complex environments," in Making Decisions Under Stress, Implications for Individual and Team Training, American Psychological Assoc., Washington, DC.

KEYWORDS: Decision-making, Modeling and Simulation, Cognitive Task Analysis, Human Factors

N00-075 TITLE: Low-Distortion Microwave Active Filters

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: This work seeks to exploit advances in circuit design to develop rapidly tunable, low-distortion microwave active filters for commercial and military applications

DESCRIPTION: With commercial and military electromagnetic systems for communications, radar, and electronic-warfare applications moving toward multi-signal, frequency-agile operation, microwave filter technology has become a critical issue. Particularly needed are filters offering broad (and for military applications, rapid) tunability, low distortion, small size, and affordability.

Microwave filters that employ active circuit elements to enhance frequency selectivity can be made very small and at a low cost, but exhibit higher levels of signal distortion than can be tolerated in most multifunction systems. Approaches that surmount this limitation through reliance on novel circuit architectures are being sought. Bandpass performance goals include: wide center-frequency tunability (ultimately seeking 5:1 tuning ratios at frequencies in the 1-to- 20-GHz range, with separation into multiple sub-bands initially acceptable), low intermodulation distortion, low passband insertion loss, and high out-of-band rejection. The ability to vary passband width is also desirable. Initial approaches should focus on receiver applications where incident signal levels do not exceed 1 W, with subsequent efforts aimed at accommodating higher power levels. The work should be structured into three phases.

PHASE I: The contractor shall design, numerically simulate, and experimentally demonstrate an active-circuit approach to microwave bandpass filter design that has the following performance goals: passband center-frequency tunability over an octave anywhere within the 1-20 GHz band, a third-order intercept point greater than 30 dBm, low passband insertion loss of less than 0.5 dB, and an out-of-band signal rejection better than 60 dB. The ability to also vary the passband width is desirable, ultimately seeking to achieve 50-to-500 MHz variability in 1-5-GHz band, and up to 2 GHz variability in the 4-20 GHz band. Phase I work should focus on incident power levels up to 1 W.

PHASE II: The contractor shall optimize the design of the prototype filter demonstrated in Phase I to fully achieve stated performance goals, while extending center-frequency tunability to accomplish a 5:1 tuning ratio, possibly through division of the aggregate tuning range into multiple sub-bands. The optimized design shall be reduced to practice. A commercialization and manufacturing plan shall be developed. Approaches suitable for transmitter applications at high power levels (over 1 kW at 5 GHz and 250 W at 20 GHz) should also be addressed in Phase II.

PHASE III: The contractor should be able to compete in the market place as a supplier of high-performance tunable microwave filters for commercial communications and military EM systems.

COMMERCIAL POTENTIAL: This work is expected to engender low-cost, wideband- tunable, low-distortion filters for wireless communications.

KEYWORDS: microwave: filters, active, tunable

N00-076 TITLE: Wide Bandgap AlGaN Based Solar Blind Ultraviolet Photodetectors

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: Develop compact high solar blindness, high sensitivity and low dark current ultraviolet photodetectors based on AlGaN wide bandgap semiconductors.

DESCRIPTION: Compact solid-state solar blind ultraviolet photodetectors are needed as sensors in potential applications such as missile defense and countermeasures, covert space-to-space communications, portable battlefield chemical/biological warfare analyzers, flame detection and control. A key characteristic in such devices is their solar blindness, that is the capability to detect light with wavelengths <270 nm, while being insensitive to longer wavelength radiation. Another important attribute is the detector sensitivity, as the light intensity in the UV region is much lower than in the visible or infrared spectral region due to atmospheric absorption. Current solid-state UV photodetectors are based on Si, SiC and diamond materials. Because they have indirect bandgaps and because Si and SiC are not intrinsically solar blind, these materials lead to devices that poorly qualify for the applications envisioned. An alternate approach is to utilize AlGaN materials to take advantage of their direct bandgap, intrinsic solar blindness in the spectral region of interest. The purpose of this effort is therefore to investigate and produce high solar blindness, high sensitivity and low dark current AlGaN based UV photodetectors.

PHASE I: Demonstrate the fundamental technologies necessary to produce high solar blindness, high sensitivity and low dark current AlGaN UV photodetectors. Design and test optimum device type and structure for the applications envisioned.

PHASE II: Produce, package and demonstrate operational, high solar blindness, high sensitivity and low dark current AlGaN UV photodetectors.

PHASE III: Develop reliable AlGaN UV photodetector product applicable for integration in missile defense and countermeasure systems, covert space-to-space communications, portable battlefield chemical/biological warfare analyzers, flame detection, flame combustion/engine control and monitoring, etc.

COMMERCIAL POTENTIAL: Such detectors will be useful for space-to-space communications secure from detection by Earth-based receivers by taking advantage of the absorption by the ozone layer in the 250-300 nm spectral region, for controlling the operation of UV light sources, UV exposure, and in UV astronomy. These photodetectors will also be effective in battlefield situations where toxic chemicals or biological reagents may be released. The physical robustness of AlGaN materials make such devices particularly attractive for applications in a high temperature environment (e.g. flame / combustion control) and in outer space.

REFERENCE: M. Razeghi and A. Rogalski, “Semiconductor ultraviolet detectors,” Journal of Applied Physics 79 (1996), 7433-7473.

KEYWORDS: ultraviolet photodetectors; AlGaN; solar blindness; missile defense; sensor; flame detection.

N00-077 TITLE: Four dimensional (4-D) Atmospheric and Oceanographic Instrumentation

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: Develop low-weight, low-power, and low-volume instruments/sensors/techniques to autonomously measure atmospheric and/or oceanographic parameters.

DESCRIPTION: Innovative sensors and measurement techniques are solicited to obtain meteorological and oceanographic (METOC) variables (e.g., physical, chemical, optical, acoustic, geophysical or biological) in 3-D space and time. The emphasis should be placed on (1) novel approaches and concepts for measuring a particular parameter coherently in 4-D, (2) observations that can be conducted as autonomously as possible (i.e. for independent operation on Remotely Piloted Aircraft (RPA), Autonomous Underwater Vehicles (AUV’s), buoys or with expendable instruments), (3) providing a significant reduction in instrument weight and volume without reducing fidelity or resolution as compared to current state-of-the-art devices, and (4) developing the next generation of low cost, potentially expendable instrumentation usable in both navy operational scenarios as well as in S & T environmental data collection. Examples of some of the types of instruments solicited include: bathythermographs, in situ ocean wave directional spectral instruments, instruments capable of measuring near-surface atmospheric parameters and the next generation of low cost METOC expendable instrumentation. The term Expendable Instrumentation includes both one time usage as well as long time in situ usage, and the sensors should be affordable if expendability is required but reusable if not. Included are instrumentation development efforts that would result in significant improvements and costs savings for existing expendable instrumentation, or would develop new expendable capabilities for measurements currently obtainable by other means (such as aerosol properties, visibility, IR extinction, etc.). All platform deployment scenarios (shipboard, submarine, and aircraft) are included. Priority is given to devices that can lead to substantial improvements in anti-submarine warfare (ASW), mine warfare (MIW), ship self-defense, airstrike targeting and special operations, through improved battle space environmental knowledge.

PHASE I: Provide both an exact description of the parameter to be measured including accuracy and sensitivity along with the instrument design concept for achieving the measurement.

PHASE II: Produce a viable prototype system and demonstrate its ability to support field measurements from an operating research platform.

PHASE III: Transition the technology to scientific use in the atmospheric, oceanographic or environmental monitoring research communities, and operational DOD systems.

COMMERCIAL POTENTIAL: New instruments can be used in a wide variety of commercial environmental monitoring systems.

KEYWORDS: meteorology; oceanography; instruments; miniaturize; automation; expendable

N00-078 TITLE: Heavy Power Transmission for Positioning and Actuation

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Demonstrate an advanced user-friendly reliable and maintainable lightweight, small footprint, omni-directional human-strength-amplifying for use on surface vessels.

DESCRIPTION: The U. S. Navy has the mission to conduct, develop, and deploy technologies for handling and transportation of ordnance and cargo, and operations of weapon systems with variable and high rates of fire. Though manpower is a primary component of all weapons/cargo handling functions, the most critical function is loading (mating) the weapons to the weapon systems due to the precision required in positioning heavy payloads in storage or in preparation for launch. Manpower is also a primary component of cargo handling, which needs to be reduced through automation, while increasing safety and speed of operation. This effort will develop the needed technology, design and demonstrate a heavy power transmission system for positioning and actuation. The designed system should have the ability of lifting payloads in the range of 100-3000 lbs, with a safety factor not less than 2. In addition the positioning accuracy should be within a small fraction of an inch. This may require a more sophisticated approach than presently available, especially with regard to manipulation of ordnance.

PHASE I: Design a system for precise positioning for heavy loads, through both rotational and translational motion. This system should have full control of the motion, and act as a human amplification for material handling applications.

PHASE II: Develop and test a scaled down prototype that can be operated by a single individual to manipulate and load ordnance/stores and translate the fidelity of control/motion generated through the individual's inherent eye-hand coordination to the respective payload.

PHASE III: Prepare a full scale design of an ordnance handling system which is adaptable to multiple surface platforms (i. e., aircraft carriers, landing helicopter assault ships, ammunition/supply ships etc.

COMMERCIAL POTENTIAL: The technology developed under this effort can be used by commercial shipping, warehousing, chemical/munitions manufacturing, mining and a multitude of other applications where man can be replaced by machine for heavy, precise manipulation of heavy or dangerous materials.

REFERENCES: Proceedings of the IECON/International Conference on Industrial Electronics, Control, and Instrumentation. International Conference on Industrial Electronics, Control, and Instrumentation; Bekey, George A., Autonomous robots. (DIGITAL); Browne, Antony, Neural network perspectives on cognition and adaptive robotics.

KEYWORDS: Ordnance, weapons, material handling, robotics, power transmission, logistics

N00-079 TITLE: Conjugated Polymers for Corrosion Inhibition

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Enable scientists to explore the feasibility of using conjugated polymers as replacement for chromium in corrosion inhibiting applications, and to explore the feasibility of synthesizing large quantities of conjugated polymers via an environmentally benign route.

DESCRIPTION: Electrically conducting polymers show great promise for use as corrosion inhibiting coatings. The mechanism of corrosion protection by conductive polymers is still unproven, but may involve annodic protection. The corrosion protection appears not to be sensitive to the absolute value of electrical conductivity above some threshold value. It may turn out that the life time of the coating depends on the starting conductivity but not enough is known. The particular polymer of interest is poly(bis-N-methyl-N-hexylamino phenylene vinylene), which has been demonstrated to protect aluminum alloys from corrosion in istonic sea water. This polymer has an intrinsic conductivity of about 10exp(-10) S/cm in the undoped state. The conductive polymer can be stabilized with conventional UV and antioxidant additives in coating formulations. The purpose of this effort is to scale-up the current synthesis to 1-2 kilograms of this polymer and to find more environmentally benign alternatives to the current synthetic procedure described in the reference.

PHASE I: Synthesize 1-2 kilograms of polymer using the literature procedure. Perform small scale (10-20 grams) test reactions on environmentally benign alternatives.

PHASE II: Improve and refine the alternative methods.

PHASE III: Transition the environmentally benign method to 10 –20 kilogram scale.

COMMERCIAL POTENTIAL: Corrosion costs the US industry alone over 10 billion dollars per year. If a suitable replacement for chromium could be found, the payoff would be tremendous for both civilian and military applications.

REFERENCES: Stenger-Smith, J. D., Zarras, P., Merwin, L. H., Shaheen, S. E., Kippelen, B., and Peyghambarian, N., Macromolecules, 31(21), 7566-7569 (1998).

KEYWORDS: Conducting Polymer, corrosion protection, environmentally benign synthesis.

N00-080 TITLE: Low Thermal Conductance Torque Tube

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop design methods, material selection criteria, and construction techniques for low thermal conductance, lightweight motor torque tubes (shafts) for low speed, high torque, superconductive ship electric propulsion machinery.

DESCRIPTION: The Navy has selected the High Temperature Superconducting (HTS), ac synchronous motor as an advanced machinery technology to be investigated and developed for ship electric propulsion systems. The torque tube of this motor is in physical and thermal contact with the rotating HTS field winding and is a major source of unwanted heat input to the superconducting magnets, which are maintained at cryogenic temperatures. Minimizing this heat leak is essential for the optimum performance of the HTS magnets and for the heat load on the cryogenic refrigeration system of the motor. High strength methods of attaching the end connections to the torque tube shall be developed. Test samples of candidate composite materials shall be measured to determine their thermal conductivity and mechanical stress and strain properties at room temperature and at temperatures of 20 K or lower. Test specimens of the developed torque tube/end connection attachment methods shall be fabricated and measured for mechanical strength and reliability over the temperature range of 20 K to room temperature.

PHASE I: Investigate and develop low thermal conductivity, composite material, torque tube designs and fabrication techniques that will have the capability of transmitting more than 1.8 million Newton-meters of mechanical torque. Methods will be developed and materials selected to fabricate the torque tube and its warm and cold end connections.

PHASE II: Design, fabricate and test reduced scale, model torque tube assemblies. A scaling analysis shall be performed to select the appropriate reduced size torque tube that will accurately duplicate the mechanical and thermal properties of a full-scale torque tube and its end connections. A sufficient number of model torque tubes, with warm and cold end attachments, shall be fabricated and tested to develop a property data base and verify the consistency and adequacy of the measured mechanical and thermal properties. The model torque tubes will be tested under the same conditions of mechanical stress, strain and temperature that will be experienced by the full size torque tube of a 19 megawatt (25,000 hp), ship propulsion, HTS synchronous motor. A sufficient number of tubes, having the best measured performance properties, shall be selected for testing to failure to determine the ultimate strength and mechanical fatigue properties of the design and fabrication methods used.

PHASE III: Design and fabricate a full size torque tube with its end connections for a 19 megawatt, ship propulsion, HTS synchronous motor. The full size torque tube unit will be tested to full-scale motor parameters.

COMMERCIAL POTENTIAL: The development of high efficiency, HTS motors at power levels of 5000 hp to 25,000 hp will have significant commercial applications in industry, manufacturing and commercial ship propulsion. High strength, lightweight, and non-metallic motor torque tubes will also have commercial application in normal conducting electric motors and other rotating machinery and engines. The torque tube design and construction methods developed can also be applied to static, non-rotating applications such as lightweight, high strength, low thermal conductivity supports for equipment and components.

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1. Kalsi, S., Gamble, B., Bushko D., "HTS Synchronous Motors for Navy Ship Propulsion," Proceedings of the Naval Symposium on Electric Machines, October 1998.
2. Doyle, T., Stevens, H., Robey, H., " An Historical Overview of Navy Electric Drive," Proceedings of the Naval Symposium on Electric Machines, July 1997.
3. Gamble, B., Goldman, J., "High Temperature Superconducting Motors and Generators for Submarines and Surface Ships," Proceedings of the Naval Symposium on Electric Machines, July 1997.
4. Schiferl, R., Zhang, B., Driscoll,D., Shoykhet, B., Dykhuizen, R., "Development Status of a 125 HP Superconducting Motor," Advances in Cryogenic Engineering Materials, Plenum Press, NY, 1996
5. Dade, T., "Advanced Electric Propulsion, Power Generation and Power Distribution, Naval Engineers Journal, March 1994.

KEYWORDS: propulsion, motors, superconductivity, composites, torque tube

N00-081 TITLE: Quiet Turning and/or Nonrotating Devices for Marine Propulsion

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Develop a quiet turning device for marine propulsion utilizing changing shape or geometry at the exit of a shrouded propulsor, perhaps using smart materials, to effect turning of the momentum vector over the speed range up to 30 knots with low acoustic signatures and water surface disturbances. Apply smart materials, such as magnetostrictive actuators, to marine propulsion using a traveling waveform along the axis of an internal tube to force the fluid with high momentum and thus eliminate traditional rotating machinery in the through flow.

DESCRIPTION: Traditional turning devices such as rudders produce cavitation and vibration unacceptable in some signature and habitibility conditions, and produce large wakes with environmental erosion in confined waters. The desire is to use shrouded propellers to shape the ship wake to minimize these adverse effects. The need is to develop a turning method that does not require a redirection of the shrouded propeller. It is envisioned that some form of geometry deformation, perhaps using smart materials and sensors, would be employed to deflect the exit flow to effect a turning vector. An alternate or additional effort would be directed at replacing traditional propulsors with novel concepts. Traditional rotating propulsors are subject to cavitation and vibration that is often performance degrading from the perspective of noise and maintenance. The need is to develop a propulsor that does not include a traditional rotating propeller or other so-called blade row. An alternative is a device that uses a streamwise deformation of the bounding surface of an internal flow path to impart energy to the water to effect forward propulsion. The emergence of smart materials and sensors makes possible the deformation of the surface of an internal passage in such a way as to effect a momentum transfer to the water and a consequent forward force on the vehicle.

PHASE I: Perform studies of the cost and realistic design for a 25,000 HP device

PHASE II: Design the device with specific attention to efficiency, cavitation, vibration

PHASE III: Conduct model scale demonstrations at approximately 12th scale – this phase will entail assess to and generation of classified reports.

COMMERCIAL POTENTIAL: This system could be used to reduce wake erosion and other environmental impact, and can reduce on-board vibrations adversely affecting human habitability.

KEYWORDS: Propulsors, smart materials, marine vehicles, wakes, hydrodynamics, cavitation

N00-082 TITLE: SiC Bipolar Junction Transistor (BJT) High Power Switch for the Advanced Quite Electric Drive Motor

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors/Electronics/Battlespace

OBJECTIVE: Develop a high speed, high power, high current and voltage SiC Bipolar Junction Transistor (BJT) switches for incorporation into the new advanced ship board electric propulsion system-quite electric drive.

DESCRIPTION: Advanced motor technology will require substantially larger, more efficient and very high-density power electronics for control and quite operation. Conventional power electronics will lead to a motor controller that is large, heavy and costly due to the need to stack large numbers power switches, manage the heat losses and incorporate large low frequency filter capacitors and inductors. A recently published paper(1) indicated that an old class of devices, Bipolar Junction Transistor (BJT), becomes a SUPER TRANSISTOR when on Silicon Carbide. Thus, a SiC BJT power switch provides the power density, voltage range and high frequency switching that can enable new, innovative motor control designs essential for the Advance Quite Electric Drive. The advantages of the SiC BJT device must be exploited. To be competitive these devices must show 10X improvement over conventional silicon IGBT or similar devices. We are looking for device operation at switching frequencies between 20 and 150KHz under load, with a blocking voltage between 2500 and 4500V and at currents between 100 and 300A. Since this technology will ultimately be incorporated into Navy systems, there must be a heavy emphasis on robust operation, high reliability and low cost manufacturing.

PHASE I: Develop, fabricate and demonstrate 2500 V and 4500V BJT devices. Develop, optimize and demonstrate functioning and operating BJT power switches at their target currents and switching frequencies. Integrate these switches into a suitable package along with companion SiC diodes to form functional half and full bridge modules. Test, characterize and evaluate BJT power device performance in a power electronics circuit. Demonstrate device processing and fabrication on large diameter SiC wafers of 75 mm or greater.

PHASE II: Customize the device to the Navy advance motor control application by coordinating with Navy contractors, and manufacture robust BJT devices that are packaged to conform to the advanced propulsion system requirements for motor controllers. Develop a module package containing switches and rectifying diodes. Collaborate with the motor control designers to incorporate this technology in power electronics system and reduce the total system costs with this SiC technology.

PHASE III: Customize the device to the Navy advance motor control application by coordinating with Navy contractors, and manufacture robust BJT devices that are packaged to conform to the advanced propulsion system requirements for motor controllers. Develop a module package containing switches and rectifying diodes. Collaborate with the motor control designers to incorporate this technology in power electronics system and reduce the total system costs with this SiC technology.

COMMERCIAL POTENTIAL: Advance motor control for commercial luxury ships, heavy-duty motor control for mining application where high temperature operation is an issue. Utility level solid state breakers and switches.

REFERENCES: 1) Jue Wang and B. W. Williams; "Evaluation of High-Voltage 4H-SiC Switching Devices"; IEEE Trans. Electron Devices (ED), vol. 46, p. 589, March 1999, and 2) The following WEB Site http://pebb.onr.navy.mil

KEYWORDS: Silicon Carbide, Bipolar Junction Transistor, and Advanced Quiet Motor

N00-083 TITLE: <u>Development of a Finite Element Analysis for Failure Prediction of Large Composite Structures Under Dynamic Loads</u>

TECHNOLOGY AREAS: Ground/Sea Vehicles

OBJECTIVE: Develop add-on software modules for commercial finite element programs to address failure predictions of large composite structures under severe thermo-mechanical dynamic loads.

DESCRIPTION: The increased emphasis in composite material applications has brought a demand for accurate failure predictions of composite structures under service loads. The design and analysis of engineering components relies on the finite element (FE) method. However, the current state of failure analysis of engineered composite components using FE methods is inadequate. The problem lies in the fact that composites are made up of at least two uniquely different materials (constituents) that have drastically different properties. Failure in a composite initiates at the constituent level and, in fact, may be limited to a single constituent. Current FE structural analysis technology smears the properties of the constituents and models the composite as an idealized homogenous material. As a result, critical information about the failure state of the individual constituents is sacrificed.

Recently developments in microstructural theories (MST) and their associated numerical algorithms allow constituent stress and strain fields to be extracted from those of the composite during a routine structural finite element analysis with a minimal computational time penalty. Constituent information allows implementation of failure prediction methodology at the constituent level where failure initiates. Although MST has been proven to increase the predictive accuracy of elastic behavior in composite laminates composed of unidirectional (two constituent) layers, the theories must be extended to accommodate woven fabrics with viscoelastic (time and rate and temperature dependent) material behavior typical of large composite structures.

Improvements in a rate dependent kinetic theory of fracture (KFT) for polymeric materials have also been recently achieved. The combining of these theories (MST and KFT) holds particular promise in the area of damage mechanics. MST allows modeling of composite failure based on mechanisms developed at the constituent level and examining their progress to the structural level. The most prominent failures to be studied are matrix degradation and reinforcement rupture based on stress states within the matrix material. Thermo-viscoelasticity theory should be implemented in an MST capable FE code. Matrix based KFT should be incorporated into the viscoelastic, dynamic loading capable FE code.

PHASE I. Develop the finite element micromechanics models necessary for an MST analysis of woven fabric composites.

PHASE II. Interface the MST's developed in phase I as user-defined-modules to commercial finite element programs such as ABAQUS, ALGOR, ANSYS, MARC, NASTRAN, and NISA. Develop additional microstructural models to accommodate particulate reinforced and chopped fiber composites which are common in industry applications. Develop accurate constituent based failure criteria for the microstructural models and establish an MST material database.

PHASE III. Bring the commercially developed software to market. The software should maintain high computational efficiency and numerical accuracy while being cast within a traditional FE analysis. Extend the MST material library/database through material testing and micromechanics development. Make material database available (fee based) through a World-Wide-Web page.

COMMERCIAL POTENTIAL: The finite element industry currently has annual revenues of $300 million. The industry is experiencing steady growth of 10-15% annually. The current finite element composite market represents 5-10% of total revenue. The unique capabilities contained in the software discussed are not available in any general purpose finite element software currently on the market. Consequently, there is a high potential for penetrating the finite element analysis of composite materials market, as well as a high potential for rapid long term growth of a company. Furthermore, the software developed is expected to significantly improve current design methodologies for composite structures.

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1. Garnich M.R. and A.C. Hansen, "A Multicontinuum Theory for Thermal-Elastic Finite Element Analysis of Composite Materials, Journal of Composite Materials, Vol. 31, No. 1, 1997.
2. Garnich M.R. and A.C. Hansen, "A Multicontinuum Approach to Structural Analysis of Linear Viscoelastic Composite Materials, Journal of Applied Mechanics, Vol. 64, No. 4, 1997.
3. Hansen, A.C. and J. Baker-Jarvis, "A Rate Dependent Kinetic Theory of Fracture for Polymers", International Journal of Fracture, Vol. 44, 1990

KEYWORDS: Composite materials, failure, finite element analysis, multicontinuum, constituents, micromechanics, microstructural, dynamic

N00-084 TITLE: Composite Gun Barrel

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop autofrettage techniques and composite material outer wraps for Naval gun barrel applications.
The navy has a requirement a composite light-weight rifled gun barrel suitable for high energy projectiles and propellants. The barrel must have superior fatigue life and superior cooling and heat dissipation characteristics. Composite material contributions to these capabilities are expected to include: superior residual stress patterns (resulting from swage autofrettage) and cooling characteristics (due to internal liquid cooling passages woven into the outer composite wrap structure).

DESCRIPTION: The contractor will develop and test composite materials and manufacturing techniques (weaving, wrapping, autofrettage, etc.), which could be used to produce a gun barrel with superior cooling, wear and dynamic performance characteristics for the DD 21 Advanced Gun System. Presently, mono-block steel gun barrels are swage autofrettaged. This process greatly increases the safe fatigue life of such barrels. This project would explore applying this technique to composite barrels. Autofrettage techniques would be explored that would leave residual compressive stresses formed by plastic deformation for superior fatigue life. Composite materials might be used as outer wraps to an inner metallic and/or composite gun barrel tube creating a hybrid rifled gun barrel. The ultimate goal would be to produce a gun barrel for the DD 21 Advanced Gun System with superior safe fatigue life, cooling, and dynamic performance.

PHASE I: Develop engineering data and materials to support gun barrel application of composite materials. The contractor will analyze the precise in-bore environment (temperature profile, pressure) and wear characteristics of the proposed charge and projectiles. The contractor will then propose composite materials (e.g.: carbon/carbon, etc.) and manufacturing techniques that would offer superior cooling capability, dynamic stiffness, and strength for the AGS barrel.

PHASE II: Phase II will consist of construction of a prototype barrel using the proposed composite over wrap techniques followed by swage autofrettage processing. Emphasis will be placed on the outer wrap's ability to keep the inner composite/metallic rifled inner tube below alloy steel austentizing temperatures, and the ability to support and contain the residual stresses from swage autofrettage.

PHASE III: Phase III will consist of transition of the composite outer wrap concept and swage autofrettage technique into the AGS manufacturing process. The SBIR contractor will serve as the technical liaison and component supplier (if applicable).

COMMERCIAL POTENTIAL: Composite/Metallic manufacturing techniques have been used in many aerospace structural applications. However, the challenge of applying such techniques to the high temperature, high-pressure environment of a major caliber gun barrel is unique. Additionally, it is not know how well the residual stresses resulting from the swage autofrettage process would be retained by such a hybrid barrel. Such a process would be applicable to a wide range of industries where high pressure/high temperature environments are present. Examples would include automotive (engine components), mining, jet engines, pressure vessels subjected to cyclic high pressure loading, and rocket motors.

REFERENCES: AGS Performance Specification on Barrel Life and Rate of Fire dated May 1999

KEYWORDS: Barrel, Wear, Plating, Gun, Composite, Autofrettage.

N00-085 TITLE: Development of a LonTalk Drive Chip (LDC) for High Performance Custom LonTalk Nodes

TECHNOLOGY AREAS: Ground/Sea Vehicles, Sensors/Electronics/Battlespace

OBJECTIVE: Develop and demonstrate a LDC that implements the lower 3 layers of OSI protocol stack, uses any microprocessor and allows microprocessor to communicate directly to the LonTalk network.

DESCRIPTION: Although LonWorks provides a level of flexibility and interoperability in distributed control that has never been realized before now; there are shortcomings. The primary one being that all LonWorks products are based on a Neuron chip. All Neuron chips are 8 bit microprocessors running at 5, 10, or 20 MHz. This provides limited computing power especially in light of some of the speed critical applications. To compensate for lack of computing power, it is possible to create a hosted node configuration. Essentially a hosted node is a combination of Neuron and a higher level processor. The Neuron then acts as a communication gateway to the LonTalk network, and the higher level processor performs all the application tasks. The processor can then communicate to the Neuron either through a parallel port or shared memory. Though more powerful than a stand alone Neuron, the hosted note design has its own set of drawbacks. These drawbacks include larger board size, communication speed limited by Neuron, 15 address table bindings in Neuron, and programming a hosted node is very different than programming Neuron (longer learning curve).

PHASE I: Develop the preliminary design of a LDC and do a feasibility study of creating a 'system-on-a-chip' (SOC) version. The LDC would allow nodes to be created without the use of a Neuron chip. It should allow a single microprocessor to be connected directly to more that one LonTalk network. The SOC refers to integrating the LDC, microprocessor, and other external devices into a single chip..

PHASE II: Construct an affordable LDC. Demonstrate full functionality as a full LonTalk node, significantly higher throughput than a Neuron chip, and on two different microprocessors.

PHASE III: Bring commercially designed LDC to market. The chip should maintain robustness, reliability, be compatible with commercial systems and be affordable.

COMMERCIAL POTENTIAL: Automation is increasing in use and complexity in industry. The LDC would have application in complicated machinery control, routers and supervisory nodes responsible for maintaining the availability of network services.

KEYWORDS: LonTalk, network, machinery control.

N00-086 TITLE: Metrics for Evaluation of Cognitive Architecture-Based Collaboration Tools

TECHNOLOGY AREAS: Information Systems

OBJECTIVE: Develop measures of effectiveness for the application of collaborative technologies/tools to complex, higher order decision making.

DESCRIPTION: Collaborative tools have focused on the retrieval, processing and presentation of data for decision making and the information technology capabilities necessary to support this function. There has been little effort directed toward assessing the value of collaborative tools when used to support decision making that involves complex cognitive functions and the solution of judgmental, course-of-action problems that are time sensitive and dependent on diverse, rapidly changing sources of data. Progress is being made in the development of descriptive models of these cognitive processes and have been presented in the form of cognitive architectures. Methods are needed to assess collaboration tool performance in support of these processes.

PHASE I: Develop a taxonomy of cognitive architectures that could be applied to high-level decision making and develop a taxonomy of collaborative tools that could be aligned with complex cognitive processes. Propose a methodology that would evaluate the utility of collaborative tools across various situations where cognitive architectures are used in high level decision making.

PHASE II: Explore available evaluation tools from past and current domains. Select candidate tools and demonstrate their utility through empirical test. Develop metrics for the application of collaborative tools to a range of cognitive architectures.

PHASE III: Prepare generic guidelines for evaluation of collaborative techniques and provide software, procedures and instructions for application. Demonstrate and quantitatively evaluate selected procedures in an operational setting.

COMMERCIAL POTENTIAL: The guidelines and evaluation tools could be applied to a wide range of economic, corporate and national political decision making situations.

REFERENCES: Gray, W.D., Young, R.M., & Kirschenbaum, S.S., HUMAN-COMPUTER INTERACTION: Introduction to Special Issue on Cognitive Architectures and Human-Computer Interaction, 1997, Volume 12, pp 301-309. Klein, G., (1998), Sources of Power; How People Make Decisions, Cambridge: The MIT Press.

KEYWORDS: Collaborative; Cognitive; Decision-Making; Metrics; Evaluation; Taxonomy

N00-087 TITLE: Real-Time Operator State Assessment Technologies

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop, integrate and test state-of-the-art technologies (e.g., dry electrode biosensors, miniature eye-activity recording cameras) and algorithms for the purpose of detecting fatigue and very high workload states within individual human operators of process control consoles or vehicles.

DESCRIPTION: Three factors present the opportunity and requirement to monitor human operator state in real time. First, there is significant pressure to optimize manning in numerous military and commercial settings, resulting in greater job demand for members of rightsized organizations. The resulting greater job demand increases the likelihood that operators will encounter periods of drowsiness and periods of task overload – potentially disastrous to any system. Second, the evolution and development of video and electrical sensor technology presents the opportunity to obtain psychophysiological state data in a nearly unobtrusive manner. Dry electrode technology will allow collection of heart and brain signals without typical electrode preparation, as is required currently. Advances in video signal processing make for robust and low cost collection of eye activity data (blink, fixation, pupil measures). Finally, significant advances in signal processing techniques of psychophysiological data makes possible the near real-time assessment of operator state. There is now significant need and technological opportunity to develop a robust operator-state monitoring system for use in military (aircraft cockpits, command and control consoles) and commercial environments.

PHASE I: Procure and test biosensor technologies (e.g., dry electrodes, eye activity monitoring systems) for robust and high fidelity data acquisition. Design operator state system for phase II.

PHASE II: Build a prototype operator state monitoring system that would obtain psychophysiological data and return measures reflecting operator state of arousal (drowsy through overloaded). Using psychophysiological algorithms developed by DON and other agencies, test and refine the system within several operational environments (simulated process control, vehicle operation). Finally demonstrate the system within an actual operation environment.

PHASE III: Develop a field-ready and marketable operator state assessment system using technologies and concepts developed under Phases I and II. The system should be modular, allowing flexible configuration of biosensors for specific application environments. Success of the system would enable transition of the system to next generation USN and USAF aircraft and tri-service command and control environments. Detection of drowsiness and the desire to avoid high workload states are common themes central to the development of many next generation human-centered systems.

COMMERCIAL POTENTIAL: Commercial potential is significant. Commercial trucking, railway, airline, and process control environments (e.g., air traffic control, power plant operation) have use for operator state monitoring. "Black box" devices designed to collect vehicle system information are beginning to appear in personal automobiles. Easily augmented with operator state data, these devices could become required by law and an industry standard within 10 years.

REFERENCES:

1. Alertness/Vigilance - Relevant Publications, Scott Makeig, Tzyy-Ping Jung, and colleagues, Naval Health Research Center, San Diegohttp://www.cnl.salk.edu/~scott/alert.html

2. Adaptive Interface Technology, Crew Systems Interface Division, Air Force Research Laboratory, Point of Contact: Michael W. Haas PhD. (937)-255-8768
http://cfhnetra.al.wpafb.af.mil/new_docs/hecpb.html

3. Eye activity correlates of fatigue during a visual tracking task, Van Orden, KF, Jung, T-P. & Makeig, S. http://mac088.nhrc.navy.mil/Pubs/Abstract/98/4.html

4. Eye activity correlates of workload during a visuospatial memory task. Van Orden, K.F., Limbert, W., Makeig, S., & Jung, T-P. Submitted. Preprint available, vanorden@spawar.navy.mil

5. 3D visualization and eye-controlled interaction. Pastoor, S., Liu, J., & Renault, S. IEEE Transactions on Multimedia, 1(1) 1999.

6. Van Orden, K. F., Jung, T-P., & Makeig, S. (1999). Combined eye activity measures accurately estimate changes in sustained visual task performance. Submitted.

KEYWORDS: operator state, biosensors, eye activity, eeg, fatigue, workload

N00-088 TITLE: Optimum Organization of Maintenance Aiding Information

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Determine optimum organization and presentation of maintenance information in job-aiding and how it may vary with the maintainer's level of expertise.

DESCRIPTION: The Navy is rapidly transitioning to the presentation of maintenance documentation in electronic form. Furthermore, there is an expectation that sophisticated forms of electronic maintenance documents will be able to serve performance aiding functions. It is hoped that these performance-aiding electronic documents will make it possible for a generalized maintainer to deal with maintenance problems in a wide range of specific systems, without specialized training in the specific system. Little is known about how information should be organized to meet user needs. There are some research results suggesting that different organizations of information are most useful for users varying in their experience and expertise as maintainers.

PHASE I: Review relevant literature. Propose hypotheses concerning alternative approaches to designing the organization of information in electronic documents for maintenance aiding. Propose hypotheses concerning the interaction between expertise and optimum organization of information. Special attention should be given to the problem of effectively presenting graphic information such as large circuit diagrams on the relatively small and low resolution displays (as contrasted to paper) of portable computers. Design study to address these hypotheses.

PHASE II: Execute the alternative approaches to develop prototype versions of electronic manuals that can be compared for their effectiveness in use. Conduct an experimental comparison of their utility for users of varying levels of expertise.

PHASE III: Develop a computer-aided process for the developing of new electronic manuals consistent with the outcomes of this research and market to government and industrial users.

COMMERCIAL POTENTIAL: Nearly every industry has large scale maintenance aiding and training problems. The commercial potential of a successful product or service in this area is extremely large.

REFERENCES:
1. Thomas K. Landauer (1995) The Trouble with Computers. Cambridge, MA: MIT Press. P. 262 ff.
2. J.J. Fuller, R.P. LeBeau, A.S. Mavor, T.J. Post & C.R. Sawyer. (1988) Test and Evaluation of the Navy Technical Information System (NTIPS) An/SPA-25D Field Test Results. Bethesda, MD: David Taylor Research Center, Technical Report DTRC-88/035.
3. W.W. Zachary & J.M. Ryder (1998) Decision Support Systems: Integrating Decision Aiding and Decision Training. In: Martin Helander, Thomas K. Landauer, and Prasad V. Prabhu (Eds) Handbook of Human Computer Interaction. Amsterdam: Elsevier Science, ISBN: 0444818766.
4. Gould, J.D., Alfaro, L., Finn, R., Haupt, B., Minuto, A. (1987) Reading from CRT displays can be as fast as reading from paper. Human Factors, 29, 497-517.
5. Baggett, Patricia; Ehrenfeucht, Andrzej Conceptualizing in assembly tasks. Human Factors. 1988 Jun Vol 30(3) 269-284 6. Frey, Paul R.; Rouse, William B.; Garris, Rosemary D. Big graphics and little screens: Designing graphical displays for maintenance tasks. IEEE Transactions on Systems, Man, & Cybernetics. 1992 Jan-Feb Vol 22(1) 10-20
7. Eric L. Jorgensen. (1994) DoD Classes of Electronic Technical Manuals; Carderock Division, Naval Surface Warfare Center; Bethesda, MD; CDNSWC/TM-18-94/11

KEYWORDS: Job performance aiding; Interactive Electronic Technical Manuals; Information organization; Hypermedia, Human Computer Interaction, Mental Models.

N00-089 TITLE: Compact, Light Weight Color Night Vision Goggles

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: New electronic technology (digital and analog) creates the possibility for extremely high computational speed, in a small package, consuming low power. Those capabilities will lead to the design and development of high resolution color night vision goggles, converting inputs from infrared CCDs, CMDS sensors or intensified CCDs to realistic full color displays.

DESCRIPTION: A new generation of architectures is being employed to develop image-fusion technology that generates a full-color image of night scenes. These image processors typically combine inputs from a pair of infrared sensors, compares the intensities at each point of the return at different wave lengths and generates a full-color representation. The technology should be capable of decreasing or eliminating “blooming” effects from sensors, assigning priorities in time and space to the most information-rich sensors.

PHASE I: Develop the feasibility of implementing color night vision goggles. Refine the algorithms, define the spectral characteristics and size of infra-red or intensified CCD sensors, define the display technology to be used with the processors, design the head - mounted device.

PHASE II: Develop a working prototype of the goggle system, capable of being comfortably worn, generating appropriate color information.

PHASE III: Transition the technology to DoD and the commercial market. Possible applications include models for police, sportsmen, surveillance personnel and other organization requiring enhanced night vision capabilities.

COMMERCIAL POTENTIAL: Color night vision goggles would be of great value to policeman, sportsman, surveillance personnel, FBI and other organizations requiring enhanced night vision capabilities. Variations on this design could improve drive vision in cars and trucks traveling at night, and would be particularly useful in fog or other conditions that obscure viewing but are transparent to the infrared.

REFERENCES: A.M. Waxman, A.N. Grove, D.A. Fay, J.P. Racamato, et.al.Color Night Vision: opponent processing in the fusion of visible and IR imagery. Neural Networks, vol 10, pp.1-6, 1997. T. Roska, A. Zarandy, L.O. Chua. Color Image Processing using multi-layer structure. Circuit Theory and Design 93, Elsenier, Amsterdam, 1993.

KEYWORDS: Image fusion, infra-red sensors, head mounted displays, night vision goggles

N00-090 TITLE: Innovative Air and Surface Strike Weapons Technology

TECHNOLOGY AREAS: Air Platform

OBJECTIVE: The Navy will consider proposals in areas relating to Air or Surface Ship delivered Strike Weapon Technologies that present an extraordinary opportunity for improving the way the Navy performs Strike Warfare and extends the state-of-the-art with capabilities which in turn will become commercial off the shelf (COTS) capabilities.

DESCRIPTION: The US Navy recognizes that, at the leading edge of technology, innovation and opportunities arise from creative minds and entrepreneurs. Proposals for this program should compliment exploratory development projects focused on guidance and control for air and surface weapons, including seeker development, signal and image processing; ordnance technology including warheads, fuzing, safe and arm devices, and energetic materials; aero/structures including steady and unsteady aerodynamics associated with axi-and non-axisymetric missile airframe shapes as well as the use of composite materials for missile structural components; propulsion technology including solid rocket propulsion and airbreathing propulsion for missiles as well as propulsion for navy gun-launched projectiles; fire control/targeting/mission planning for both air-launched and ship-launched weapons; systems investigations to perform performance trade-off studies leading to affordable technology investment strategies at the component level. This call is for breakthrough technology with great market potential beyond the standards or state-of-the-art from those topics listed above, with capabilities measurable in orders of magnitude of improvement compared to existing fielded naval weapons systems. Proposals previously submitted as part of another SBIR topic or submitted concurrently are not considered acceptable. Proposals will receive a preliminary screening that may reject them without full technical review since they may not offer enough of an extraordinary opportunity; and the topic may be rejected solely on the basis that the technology does not produce a significant improvement to existing systems or commercial off the shelf items available.

PHASE I: Concept development and conduct system level bench tests. Develop Phase II Plans and identify three (3) specific commercial transitions of technology for Phase III. Identify all manufacturing plant and facilities requirements.

PHASE II: Demonstration of capabilities through actual testing of prototype production samples. Prototypes should be tested in actual operating environments, or as closely matching operational requirements as physically possible with funding levels currently expected for Phase II effort. Development of a production and manufacturing plan for Phase III. Manufacturers capable of production quantities identified in commercialization plan, and appropriate licence agreements exercised.

PHASE III: Transition technology and prototype systems into production for Commercial off the shelf (COTS) application appropriate for DOD use.

COMMERCIAL POTENTIAL: Affordable Commercial Off the Shelf (COTS) technologies and marketable items must be made available to industry and government alike at the end of the effort (phase III), and private sector applications and benefits must be inherent in the objective of the proposed effort.

REFERENCES: Sections of the 1997 Science and Technology Requirements Guidance (STRG) relating to Air and Surface Strike Technology is available in Chapter 3, Air Warfare and Chapter 4, Surface Warfare, and is available on the Internet (http://www.hq.navy.mil/N091/STRGCOVR.HTM) and information on existing Navy Systems are available from the Navy Factfile Internet Site (http://www.chinfo.navy.mil/navpalib/factfile/ffiletop.html). Air and Surface Weapons Technology (ASWT) program briefing materials with additional expectations and technology focus areas are available by request of Mr. James Chew, ONR at the numbers provided below.

KEYWORDS: Conventional Weapons; Weapons; Missiles; Ammunition; Explosives; Munitions

N00-091 TITLE: Technology for Shipbuilding Affordability

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: The objective of the project is to develop and implement innovative technologies that will reduce the cost to construct ships and thereby improve the competitiveness of the domestic shipbuilding industrial base and reduce the cost of military ships.

DESCRIPTION: During the last year, 9 shipyards along with suppliers, owners, operators, and government personnel have developed the MARITECH Advanced Shipbuilding Enterprise (ASE) Strategic Investment Plan (SIP). This plan contains an industry led strategy to promote commercial competitiveness and reduce the cost of military ships. It identifies Major Initiatives and Sub-Initiatives that are the R&D requirements for this industry. This entire plan is available for review on the World Wide Web at http://www.nsrp.org/. Coordinating with U.S. shipbuilders to adapt and implement "World Class" commercial best practices is encouraged. The application of best practices can cover areas such as production methods, production planning and control, accuracy control, supplier relations and design for Producability. Proposals under this topic can address any of the 34 research areas identified in that plan. However, six projects were awarded in June, 1999 as a result of Small Business Technology Transfer (STTR) Topic N99-01 Technology for Shipbuilding Affordability. Information on these awards is available on the Navy SBIR/STTR web site. Proposals that overlap or duplicate these ongoing STTR projects will not be considered under this SBIR topic. The following project types would be appropriate for SBIR proposals in support of the plan:

Technology Development Projects - Technology development projects targeting development of new or improved technological solutions for an individual or a narrow range of process areas. These projects are expected to have a more narrow impact on the business process and address a limited range of sub-initiatives. Examples include individual process or system development, robotic and automated tooling, new product designs, and new materials or coatings development.

Implementation Projects - Implementation projects designed to assist shipyards and other industry participants to implement and assimilate processes and technology that can be tailored to meet shipyard requirements. These projects are expected to target a single shipyard or corporation and may have either a broad or narrower focus. Examples include the implementation of new business and manufacturing processes, adaptation of product design and material standards to new market segments or shipyard processes, and the implementation of new software and robotics.

Proposals should specifically describe the technology, how it will be developed, what the estimated benefits will be and how it will be transitioned into the shipbuilding industry. Teaming with the shipbuilding industry to form integrated project execution and implementation team will improve transition potential and is strongly encouraged. Shipbuilding industry contacts for each Major Initiative are available on the web site.

PHASE I: Prove feasibility for improvements being developed and detail where and why they will impact shipbuilding affordability. Include a Return-On-Investment (ROI) analysis for industry implementation.

PHASE II: Develop a working prototype production system or prototype product to demonstrate its performance characteristics. Present the technology being developed to the MARITECH ASE Major Initiative teams, develop a commercialization (Phase III) plan, in coordination with MARITECH ASE members, including descriptions of specific tests, evaluations and implementations (including sites and points of contact) to be performed.

PHASE III: Implement the Phase III plan developed in Phase II in coordination with the MARITECH ASE Program.

COMMERCIAL POTENTIAL: The technology developed under this topic shall be applicable to commercial shipbuilding practices.

REFERENCES: MARITECH ASE Strategic Investment Plan, available on line at http://www.nsrp.org/

KEYWORDS: shipbuilding; affordability; production; manufacturing; processes; maintainability

N00-092 TITLE: Combat System Automated Testing

TECHNOLOGY AREAS: Materials/Processes, Sensors/Electronics/Battlespace

OBJECTIVE: An innovative approach for automated testing of COTS hardware and software is needed to manage combat system life cycle cost following initial development and fielding. The rapid pace of technology obsolescence and relatively low procurement cost elevate the labor for system test and integration into a major life cycle expense category. If the current labor intensive process and test methodologies could be automated, the cost of maintenance, sparing, technology refresh, and technology insertion could be dramatically reduced.

DESCRIPTION: The effort required to test and certify complex weapon systems is currently a manual, time consuming process.

COTS hardware and software are quickly becoming a normal part of the Navy's tactical shipboard environment, with lower cost/higher technology systems being introduced at an increasingly faster rate. The potential pitfall to this COTS proliferation is the cost of keeping pace with relatively short COTS supportability time spans. While the procurement cost of tech refresh itself remains relatively affordable, significant labor expense results from manual regression testing and re-certification of combat system functionality. This challenge applies to the COTS components of the shipboard tactical Local Area Networks being employed in the fleet, as well as the tradition sensor, signal processing, display, and weapons launch hardware/software strings. An innovative approach to automate the integration and test process would reduce both developmental and life cycle costs. A complete solution should consider the overall development process. This may involve up front changes in the way the system is designed or architected, changes to simulation/stimulation requirements, or requirements for additional built in test signals and/or software test code.

PHASE I: Develop a system level approach which could be applied to automation the integration and test of large, complex COTS based systems, such as the VIRGINIA Class submarine combat system, SSN688 backfit combat system upgrade, SQQ-89 surface combatant combat system upgrade, DD21 future surface combatant combat system, or any similarly challenging COTS based system/environment. This research should develop methodologies and requirements for tools that could reduce the cost and time required for initial test and integration, as well as regression testing following obsolescence replacement actions. It should identify necessary augmentations that may be needed to the tactical system or non-tactical simulation/stimulation subsystems and also provide process changes to the development efforts to ensure non-evasive techniques are established early in the design cycle.

PHASE II: Develop a prototype system that provides automated capabilities for testing a COTS combat system. The approach must be non-intrusive and fully validated against results from a proven system test baseline.

PHASE III: Establish an automated test program that is integrated with the mainstream tactical system system development efforts and can be used in multiple system applications and platforms. Provide hardware and software tools that can be augmented to existing systems or be utilized as a stand alone test support suite.

COMMERCIAL POTENTIAL: This system could be applied in any work environment where large scale COTS hardware and software systems are employed and subject to the expense of complex and time consuming test and integration. (tele-communication systems, commercial airliners, oil exploration systems, etc)

REFERENCES: Contact the TPOC listed above for access to literature on COTS combat system architectures.

KEYWORDS: certification, regression test, configuration management, change, COTS technology

N00-093 TITLE: <u>The Manufacture and Integration of Power Building Blocks and Cells for PEBB</u>

TECHNOLOGY AREAS: Materials/Processes, Sensors/Electronics/Battlespace

OBJECTIVE: Develop, manufacture and integration of power building blocks (cells) into a standardized architecture for Plug and Play Power Electronics System.

DESCRIPTION: The PEBB (Power Electronic Building Block) model and approach to has been successfully demonstrated (1) as an alternative to traditional power electronic system design. The global building blocks that comprise a PEBB are: thermal management system, the passive components used as filters, input/output interconnections, power switch modules, and partitioned controls and their related systems. In this solicitation, we wish to transform these PEBB elements into a family of manufactureable building blocks (cells) that can be assembled into a power electronics system of any topology and functional upon assembly at any power level for a variety of applications. The blocks then will have standardized interface (2,3) that are plugged together or snapped together forming a pre-engineered power system determined by the PEBB architecture. Thus, the objective of this SBIR topic is the development and manufacture of generic integrated blocks (cells) that form the smallest design unit of the PEBB. We are looking for the integration and manufacture of blocks composed of discrete power components that were previously hand assembled into the Power Electronics System. The Plug and Play concept for Power Electronics will have been demonstrated at the time of this solicitation at the PCIM Conference in Chicago, IL on 7-11 November 1999 (4).

PHASE I: Design and develop PEBB blocks such as control blocks, filter blocks, and thermal cooling blocks that can snap together and plug and play with other standardized interconnections such as the Coordinated Interconnect System, CIS, (2,3) or the IEEE Standard 1461.

PHASE II: Optimize the level of integration in each block, develop and manufacture a family of blocks for different power ranges and application, identify and standardize on plug and play interface. Demonstrate products in high, medium and low Power Electronic Systems.

PHASE III: Manufacture high reliability building blocks and supply these blocks to Naval Power Electronics Systems Developers.

COMMERCIAL POTENTIAL: These blocks (cells) will be used in nearly power electronics applications; for example in motor controllers or motor drives for industrial applications and automotive electric vehicles; in high and low voltage power supplies and power converters.

REFERENCES:
1)http://pebb.onr.navy.mil;
2) Arthur W. Kelley, Mark Harris, Dennis Hartzell, and Dennis Darcy, Coordinated Interconnect: A Philosophical Change in the Design and Construction of Power Electronic Converters, Conference Record of the 1998 Industry Applications Conference, 33rd IAS Annual Meeting, October 12-15, 1998, St. Louis, Missouri, USA, pp. 1105-1110. http://eprc.ncsu.edu/Papers/98IAS-CoordInter/99IAS-CoordInter.html
3) Arthur W. Kelley, Mark Harris, John Cavaroc, Mark Jones, Ralph Linkous, Dennis Hartzell, and Dennis Darcy, Bus Connector for Coordinated Interconnect: Laboratory Measurement and Finite Element Simulation, Record of the 1999 Applied Power Electronics Conference, March 14-18, 1999, Dallas, Texas, USA, pp. 325-331. http://eprc.ncsu.edu/Papers/99APEC-BusConn/99APEC-BusConn.html
4) http://www.powersystems.com/cfp99/pcim.html
5) http://grouper.ieee.org/groups/1461/

N00-094 TITLE: Fast-response Sensor for the Measurement of the Optical Properties and Carbon Content of Organic Aerosols

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: To measure and carbon content and optical absorption of natural and anthropogenic aerosols in the marine boundary layer from buoys or airborne platforms.

DESCRIPTION: Marine aerosols have a significant impact on the optical properties of the atmosphere. Extinction by aerosols in both solar and infrared wave-lengths strongly affects the performance of EO/IR sensors. While scatter is easily measured with existing technologies, an instrument that can measure black carbon aerosol content is lacking. Such an instrument will have a direct impact on the understanding of extinction in the marine boundary layer. A significant fraction of aerosols in marine boundary layer contain organic compounds. The chemical properties of these aerosols have a strong influence on radiative properties of the atmosphere. The black carbon content of aerosols is particularly important to the radiative impact of these particles. Current technology for measuring the optical and chemical properties of these aerosols is limited to the analysis of filter samples that must be exposed over long time periods. These sample times can be significantly longer than the time scales of processes that produce these aerosols. An instrument that can measure in real-time the characteristics of black carbon aerosols is needed to understand the optical impact of these aerosols in the marine environment. The black-carbon instrument should classify by number and size the amount of black carbon in the atmosphere at resolutions of at least one hertz.

PHASE I: Formulate initial concepts, provide theoretical or laboratory proof-of-concept sensor designs for the development of a real-time black carbon quantifying detector.

PHASE II: Fabricate a prototype black carbon detector. Conduct studies with laboratory generated aerosols to demonstrate sensitivity, time response, and accuracy. Deploy the instrument on an aircraft or ocean buoy to acquire a sample data set for analysis and evaluation of capabilities.

PHASE III: Transition prototype to a commercial product.

COMMERCIAL POTENTIAL: Organic compounds form the major fraction of urban aerosols. The potential of urban aerosols for affecting human health is clearly recognized and there is a growing demand for sensors that can monitor and quantitatively measure the properties of these aerosols for regulatory purposes. The development of a completely automated, turnkey system for both monitoring and research applications would be a very attractive commercial product.

REFERENCES: Bond, T.C., T. L. Anderson, and D. Cambell, 1999: Calibration and intercomparison of filter-based measurements of visible light absorption by aerosols, Aerosol Science and Technology, 30, 582-600.

KEYWORDS: organic aerosols, fast response aerosol sensors, aerosol carbon content

N00-095 TITLE: Real-time Interactive Analysis and Visualization Interface for Environmental Research Data

TECHNOLOGY AREAS: Sensors/Electronics/Battlespace

OBJECTIVE: Develop an interactive command and control system that records, monitors, disseminates and displays user-configurable real-time data from multiple payload to remote users, exploiting SATCOM and Internet technologies.

DESCRIPTION: Real-time data collection and monitoring require a high degree of flexibility in transmitting and representing data. Mission controllers, mission scientists and sensor engineers must have access to relevant observational data to support mission critical decisions and data quality assurance. Research efforts require that multi-sensor data are made available to remote scientific investigators, in a manner that supports their evaluation of and participation in the observational activity. Graphical interfaces must be designed to allow user-configurable transmission and display of a broad range of instrument and navigational data. Such a system must process and filter up-link commands to instruments during flight missions, as well as providing user-extensible feedback on the operational status of the sensors, data link, and aircraft. An intelligent system should manage real-time data collection, display, dissemination, command and control processing and multiple operator communications in a manner that maximizes available bandwidth and limits dropouts, utilizing interfaces to SATCOM data links and the Internet.

PHASE I: Design and develop a prototype system architecture that performs basic remote operation, real-time mission data management, dissemination, and data display.

PHASE II: Develop and demonstrate a fully capable remote site data management system for use with multi-sensor and multi-user field experiments. The system should support multiple payloads and customizable instrument displays. Develop a commercialization (Phase III) plan, including descriptions of potential customers, missions, demonstrations and transition efforts to be performed.

PHASE III: Transition the system into a commercial large-scale distributed data and display system. Support system integration for customer-specified platforms.

COMMERCIAL POTENTIAL: Private sector applications and benefits are inherent in the objective of the proposed effort. Existing data management systems used by government or private research organizations should benefit from the added interactive data dissemination and display features of this system.

REFERENCE: http://web.nps.navy.mil/~cirpas/

KEYWORDS: Real-time Data Collection; Visualization; SATCOM; Internet; Data Management; and Instrument Control